



BUSHFIRE BEHAVIOUR TRAINING & LEARNING

Examining bush fire-fighter pedagogy – the problem of learning complex practice

By

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Abstract

This thesis is concerned with the bush fire-fighting domain, where personnel are required to respond to complex, dynamic situations, drawing on their formal and informal learning to fight bushfires. South Eastern Australia is one of the most fire-prone areas of the world and agencies responsible for fire and land management face many challenges from escalating fire-weather conditions coupled with demographic changes which have increased the vulnerability of communities. At the same time increases in the turnover of personnel and emerging demands of working in extreme conditions have placed greater pressure to develop bush fire-fighting expertise. Australian bush fire-fighters need critical knowledge and skills to meet these changing circumstances and increased demands. It is therefore important to understand the complex learning needed for new and emerging competencies.

Workplaces, including work-based training, are important sites for learning. From a situated learning perspective, it is proposed that it is through engagement in activities that individuals learn and moreover, that these situational and social factors influence the knowledge that individuals construct. In addition, knowledge is conceived as being embedded in domains of activity (social practice) and how these tools are used and enacted in circumstances and activities is crucial to understanding how capabilities and expertise are formed. However, as complex practice comprises abstract, broader and more deeply associated knowledge, cognitive activity is a second and equally important domain of activity. This thesis adds to the growing body of research that seeks to explore how social and cognitive activity combine to affect learning in practice contexts. The interest here is a need to build understandings about how these factors underpin learning processes in training and how to capitalize on these to enable the requirements for more complex practice. This problematic is examined in relation to the bush fire-fighter curriculum and learning approaches.

A case study approach was used to examine different components of the bush fire-fighter curriculum. An initial research phase examined the standard curriculum and the associated teaching practices used to train bush fire-fighters. A second phase

examined a new component of that curriculum, a simulation-based approach, to understand how this facilitates understandings of *bushfire behaviour*.

As there is limited research into the novice bush fire-fighter curriculum, the first focus of the research enabled an examination of the strengths and weaknesses of current bush fire-fighter training. The findings show that there is a strong and intended emphasis on preparing novices for a deeper and broader level of skill. However, based on trainers' reflections of the experienced curriculum, concerns were expressed about whether these goals are being met. Trainees also experienced various levels of frustration. An analysis of an example of the enacted standard curriculum confirmed that the higher-level goals are not being realized.

In contrast, an examination of the simulation-based learning context suggests that learners are expected to engage at higher cognitive levels and the pattern of interaction between trainer and learner is more intensive and inclusive. The investigation also demonstrated how *a situated immersive pedagogy* affords access to the skills and knowledge critical to entry-level bush fire-fighters. The analysis and findings suggest important learning processes that enhance this learning model. The learning processes identified and conceptualised include the processes of (1) immersive 'noticing', (2) the overlapping and integrating of concepts and (3) participation and social engagement. This model of pedagogical engagement provides a conceptual framework which identifies the pedagogical skills needed for trainers to enact these learning practices.

It is concluded that for novices to build successful conceptualisation and categorization of domain problems, they require access to practice (or practice-like contexts) as well as expert guidance and feedback. However, in addition to engagement with the day-to-day actions and problems (real or simulated), trainees require access to higher orders of engagement (more mature practice). The model described furnishes strategies for application on a broader scale.

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Statement of Originality, Authority of Access and Statement of Ethical Conduct

I hereby certify that all of the work described within this thesis is the original work of the author. Any published (or unpublished) ideas and/or techniques from the work of others are fully acknowledged in accordance with the standard referencing practices. Material in this thesis has not been accepted for a degree or diploma by the University of Tasmania or any other institutions.

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The research associated with this thesis abides by the international and Australian codes on human and animal experimentation, the guidelines by the Australian Government's Office of the Gene Technology Regulator and the rulings of the Safety, Ethics and Institutional Biosafety Committees of the University.

(Annette Maree Salter)

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Chapter 1

Introduction

Learning in the workplace, whether it occurs in formal training sessions or less formally through workers observing and interacting with work-mates, is an important means of assisting organizations to achieve their goals in the face of the increasingly complex political, social and economic demands of modern society (Organisation for Economic Co-operation and Development, 2010). Workplace learning is also a major factor in the growth of the individual worker, assisting his or her personal integration with the organisation, developing bonds with team-mates and leading to a sense of accomplishment, well-being and self-worth through the mastering of the tasks required. Consequently, the study of learning in the workplace has become the focus of an expanding body of research.

However, not all workplaces are the same and some are inherently complex and hazardous, such as those confronted by emergency workers, wherein crucial decisions must often be made “on the fly”. Understanding the nature of these work environments and the development of the expertise needed to respond to them is complex (Ross, Shafer & Klein, 2006). Assumptions and generalisations about learning in less complex workplaces do not always suffice to reveal the development of expert thinking and rapid responses needed in emergency situations.

Bush fire-fighters, like other contemporary emergency workers, face numerous workforce challenges. Bushfires¹ are becoming more frequent, new *mega-fires* behave in unprecedented ways and the scientific knowledge of how these complex bushfires progress through the landscape (*bushfire behaviour*) is constantly evolving. In this context, increased expectations and new demands on bush fire-fighters are emerging, which require a deepening of the knowledge base in *bushfire behaviour*, and improvement

¹ The term *bushfire* is used in Australia and equates to the term *wildfire* used in the United States and *forest fire* used in Europe.

in bush fire-fighters' skills to be alert and respond flexibly, quickly and safely to changes in their environment. At the organizational level, dynamic, rapidly changing bushfires demand frequent adjustments in the deployment of plant and personnel in complex topographies and subject to variable physical factors such as changes in wind speed and direction (Cheney, Gould, & McCaw, 2001). Decisions must also consider limitations of access, time required for tasks such as bull-dozing fire-breaks, the nature of the fuel, the proximity of human habitation and the safety of personnel. Time-pressured decision making in these situations is fraught with difficulty (Owen & Hayes, 2014).

This thesis considers aspects of the entry-level training conducted by Australian bush fire-fighting agencies at this time of increasingly frequent, hazardous and destructive bushfire events, which impose not only increasing technical and logistical demands but also the need to accelerate where possible the individual's transition from novice to journeyman, to expert.

The thesis seeks to build on understandings about how learning experiences can be improved to build critical vocational knowledge and skills, particularly to meet the deeper, more complex skill requirements that are emerging for this vocation. It is a core assumption of my thesis that the problem of developing more skilled practitioners can be investigated as a problem of learning and this position is expanded to incorporate two theoretical perspectives (cognitive psychology and situated learning). In addition, knowledge is conceived as being embedded in domains of activity (social practice) and how these tools are used and enacted circumstances and activities is crucial to understanding how capabilities and expertise are formed. However, as complex practice comprises abstract, broader and more deeply associated knowledge, cognitive activity is a second and equally important domain of activity.

Please note that this study focuses specifically on fire-fighters involved in fighting bushfires. These includes permanent, contract and volunteer bush fire-fighters. I will use the term *bush fire-fighter* when referring to those whose roles are to fight fires in forested areas. In Australia, *metropolitan fire-fighters*' roles often extend to responding to fire in bushland near the urban fringe. However, in many countries, including Australia, the

metropolitan fire-fighter's primary role is fighting urban and structural fire and I will use the term, *structural fire-fighter*, when referring to research that specifically investigates these personnel.

Australia, particularly South-East Australia, is one of the most fire-prone regions in the world (Cary, 2012). Changing climatic conditions are expected to dramatically increase this vulnerability to *catastrophic fire events*² and recently the term *Mega-fire* (a fire that exhibits fire behaviour characteristics that exceed all efforts at control, regardless of the type, kind, or number of bush fire-fighting resources deployed) has come into parlance. Demographic changes in recent decades have increased the urban-rural interface, consequently increasing the potential impact of bushfires upon human life, habitation, infrastructure and economy. Never has it been so urgent to be able to manage the risk of bushfire.

In contrast to many workplace environments, the fire-ground is inherently dangerous, complex, volatile, physically demanding and psychologically intimidating (Hardy & Comfort, 2015). Decision making at all levels involves risk, as the dynamics of bushfire behaviour can often confound human prediction. How best to prepare novices for this workplace and how best to enhance their development towards competence and expertise is particularly crucial for Australian bush fire-fighting organizations today as they confront increasingly frequent, hazardous and destructive bushfire events (Clarke, Lucas, & Smith, 2013). Australian bush fire-fighters need critical skills to meet these changing circumstances and increased demands. It is therefore important to examine the nature of bush fire-fighter expertise and the learning which underpins it.

Managing bushfires is a significant activity for agencies such as the land management agency which provides the context for the case examined in this thesis. In Australia land owned by State and Commonwealth governments (e.g. parks, reserves, forests) are managed by land management agencies. The study considers training within a typical

² The *catastrophic fire* is a rating used in Australia to indicate the most dangerous fire conditions. In brief, these fires are extremely difficult to control and spot fires will start well ahead of the main fire and cause rapid spread of the fire and embers will come from many directions.

Australian land management agency with a focus on the initial development of understanding in critical knowledge and skills, which include knowledge of *bushfire behaviour*, during entry-level training. The science of *bushfire behaviour*, the dynamics of combustion in relation to wind, fuel and topography, can be considered as the core element on which bush fire-fighting strategies are determined, an understanding of which should accompany the acquisition of all the practical skill sets (Sullivan, Gould, Cruz, Rucinski, & Prakash, 2013).

Here it might be noted that familiar patterns of *bushfire behaviour* have changed in recent years (Handmer & O'Neill, 2016). Climate change is generating higher summer temperatures and stronger winds which contribute to an increasing incidence of catastrophic bushfires. The increased ferocity and rate of spread of these fires can confound decisions based on prior knowledge and experience. This situation can have profound effects on how bush fire-fighters can conduct their work as well as making the work essentially more risk-laden.

On this point, the Yarnell Hill Fire in Arizona (June 2013) serves as an example. In this fire, nineteen bush fire-fighters, from the same crew known as the Granite Mountain IHC, became trapped when the fire took an unexpected turn and all nineteen bush fire-fighters perished³. An accident investigation report (Arizona State Forestry Division, 2013) of this incident summed up the conditions that lead to the bush fire-fighters' immediate entrapment, as follows:

This tragedy occurred when the Granite Mountain IHC was traveling through an unburned area toward a safety zone when a rapidly advancing fire of great intensity overtook them. The fire's extreme speed of 10 to 12 miles per hour eliminated any opportunity for the crew to reach the safety zone or return up to the canyon rim (p.31).

This was a rapidly changing, high risk environment. This included; "a doubling of fire intensity and flame lengths, a second 90-degree directional change, and a dramatically

³ One additional member of the crew survived as he separated from the crew earlier that day.

accelerated rate of spread” (p. 2). Essentially, the bush fire-fighters were caught up in extreme fire conditions⁴.

In a discussion at the end of the accident investigation report (Arizona State Forestry Division, 2013), a consideration is given to the problem of making sense in extreme conditions; the report noted the following.

It is far easier for us to know how we would make sense of the situation in hindsight than it is to know how the Granite Mountain IHC made sense of it. We know that the Granite Mountain IHC was actively making sense of their situation, but we also know that their sensemaking and that of others on the Yarnell Hill Fire did not prevent this tragedy. Because other wildland fire-fighters have similar training, knowledge, and experience to the Granite Mountain IHC, it is likely that others could “make sense” in a similar manner and suffer a similar outcome (p.46).

This points to fundamental concerns about how to prepare bush fire-fighters to work in these extreme conditions where active sensemaking can test received training and experience. Recognizing the complexity that practice in these settings can present, research into expertise has broadened its perspective to encompass the community of practice known as *naturalistic decision making* (Zsombok & Klein, 2014). The broad features of this type of decision making are outlined by Orasanu and Connolly (1993) and Klein’s (1993) study of expert fire-fighters which indicates the scope of their skill, showing that they can work in time pressured, high-stake situations where there is inadequate information and that they can interpret ill-defined goals in these rich and dynamic contexts which require team coordination. Thus, in complex decision settings there are broader demands on expertise which must encompass dense, subtle and complex requirements.

⁴ In the US, Extreme Fire Behavior is described as follows; "Extreme" implies a level of fire behavior characteristics that ordinarily precludes methods of direct control action. One or more of the following is usually involved: high rate of spread, prolific crowning and/or spotting, presence of fire whirls, strong (NWCG Incident Operations Standards Working Team, 2006).

Zsombok's (1997, p.4) shorter definition of these more complex and natural decisions as "the way people use their experience to make decisions in field settings" points to the experiential and context-dependent nature of these skill-sets. However, if the field settings are becoming more and more complex and hazardous, one may question to what extent practice-based learning can prepare for effective decision making. Also as the decision setting is fundamentally complex (information in these settings can be erroneous, missing or ambiguous), the processes of active sensemaking and individual appraisal are less obvious. In turn, if skills are more opaque, complex and dense, how can practitioners be supported in individual growth and knowledge appropriation? In short, if these context-dependent skills require greater depth to deal with increased complexity one may question the adequacy of learning on-the-job in preparing bush fire-fighters for extreme conditions. At the same time, any reduction in opportunities to build skills and knowledge through practical experience increases the pressure to find training solutions for these problems. These concerns present educational challenges for this workforce, with implications not only for the safety of individual bush fire-fighters but also for the viability of the broader emergency response and its ongoing mission to protect communities.

This chapter proceeds by examining the context of bush fire-fighting in Australia (section 1). Key research is outlined which highlights the new and foreseeable demands on the bush fire-fighter skill-base within this changing context. This section then identifies the challenges and implications for training posed by these new demands. This is followed by an outline of the key focus of the study (section 2); the concepts and theories important to this study (section 3); the aims, significance of the study and the research questions posed (section 4); the key research processes used and the structure of my thesis (section 5).

1.1 The context of the study

Over recent decades there has been a marked increase in the frequency and severity of bushfires, particularly in South-Eastern Australia. Consequently, various governmental inquiries have been instigated, most notably that of the Council of Australian Governments (COAG) *Report of the National Inquiry on Bushfire Mitigation and*

*Management*⁵, in 2004 and that of the Commonwealth Government's Select Committee on Agricultural and Related Industries inquiry: *The Incidence and Severity of Bushfires across Australia*, in 2010. These were lengthy and detailed inquiries which considered submissions from a wide range of stakeholders including bush fire-fighting agencies, forest and agricultural industries, academics and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). The findings of these and other governmental inquiries underpin the following description of fire in the Australian landscape and the problems faced by bush fire-fighting agencies. Briefly summarised, the findings indicate that climate change is lengthening the fire season and reducing the window for conducting fuel-reduction burns in relative safety. The traditional source of bush fire-fighting manpower, farm and timber workers, has diminished with the increasing mechanisation of rural industries and the reduction of forest areas available for commercial management. Retirement of older, experienced personnel across bush fire-fighting agencies was also recognised as constituting a loss of expertise. The conclusion of the Commonwealth Government's Select Committee was that these and other constraints pose major challenges to the mitigation of bushfire in Australia.

This section outlines the changing context of bush fire-fighting in Australia and the implications for training. It notes the range of operational challenges facing fire management agencies, the qualities of the shifting skills base, the structure of the system response and the implications of these for the training of volunteers and professional bush fire-fighters.

1.1.1 Fire in the Australian Landscape

In its submission to the 2010 Select Committee on Agricultural and Related Industries' inquiry into "The Incidence and Severity of Bushfires across Australia", the Commonwealth Scientific and Industrial Research Organisation (CSIRO) noted that

⁵ This Inquiry was prompted by the 2002–03 fire season. This report included a review of research and previous major reports on bushfire spanning over 60 years; included consultation with every state and territory; sought advice from specialists, researchers and recognised experts; drew on submissions from the the Select Committee of the House of Representatives report (October 2003) (this was a public hearing which received over 500 submissions); drew on completed reports from the government of Victoria and the Australian Capital Territory (the two jurisdictions that were most affected in this fire season) as well as conducting an extensive consultation with these governments.

bushfires “are an inevitable occurrence in Australia”. The submission indicated that about 50 million hectares of land are burned across Australia each year on average, that lightning is the cause of almost all naturally occurring bushfires and that human activities account for most of the rest. Bushfires account for about 10 percent of the cost of all major natural disasters in Australia, and are associated with the greatest loss of life (Select Committee on Agricultural and Related Industries, 2010, p. 4, CSIRO, Submission 15, p. v).

Fire regimes across Australia vary because of differences in the rate of vegetation growth (and hence fuel production), the rate at which fuels dry out, the occurrence of suitable weather for the spread of fire across the landscape and various causes of ignition. The tropical savannas of the North tend to burn mainly in the winter-spring period and experience high frequency and relatively low intensity fire regimes. In contrast, the tall sclerophyll (eucalypt-dominated) forests of the cool, temperate South tend to burn in summer and generally have low frequency/high intensity fire regimes. The bulk of evidence to this and other inquiries related to the importance of mitigating the severity and effects of fires in Australia's southern areas because of their higher intensity and greater potential for harm (Select Committee, 2010, CSIRO, Submission 15, p. 3).

South-eastern Australia has highest risk in spring, summer and autumn. This region has the reputation of being one of the three most fire-prone areas in the world, along with southern California and southern France (Hennessy, Lucas, Nicholls, Bathos & Ricketts, 2005, p. 11.). The state of Victoria, where this study was undertaken, covers an area of 237,629 square kilometers (Bryant, 2008), and while the smallest state in mainland Australia, it is one of the most fire-prone areas in Australia and hence an important focus for this study. Victoria is geographically and climatically diverse; including alpine areas in the north east, semi-arid plains of the west and north-west and the cool, temperate southern, coastal areas (Bryant, 2008). There is some variability in the bushfire season across Victoria but generally it occurs from November to April when much of the state is dominated by hot and dry conditions of summer (Bryant, 2008).

Over the last hundred years Victoria has experienced thousands of fires, the major ones including 1939 Black Friday, 1983 Ash Wednesday, 2003 Alpine fires, 2006/2007 Great Divide Fires and Black Saturday (2009). The loss of life in these combined Victorian fires, at 473 people, is more than the loss of life in all the other Australian states and territories combined (Bryant, 2008). The Black Saturday (2009) bushfires resulted in the loss of 173 lives, over 2,000 homes destroyed and 430,000 hectares burnt.

Victoria's high bushfire risk is the consequence of a combination of factors. These include large areas of highly flammable dry eucalypt forest, expanses of highly flammable grassland and a climatic pattern of mild, moist winters followed by hot dry summers, often with protracted droughts. The risk is exacerbated by agricultural practices where fire is used routinely and an increasing population density in bushfire-prone areas, such as in the rural-urban fringe (Emergency Management Victoria, 2014).

The Steering Committee for the Review of Government Service Provision (SCRGSP) (2015) reported a significant increase in bushfires over the last decade in both number and intensity, including Victorian bushfires:

Victoria had more than 4600 grass and bushfires over the 2013-14 fire season, 78 of which were considered significant. The largest fire covered 165 806 hectares in East Gippsland and burned for 70 days. International and interstate support was received with a total of 2850 bush fire-fighters spending just over two months assisting Victoria crews in firefighting, incident control and community protection at Country Fire Authority fire stations across Victoria (p. 9.79).

While Victoria has suffered most, major fires have also occurred in Tasmania (South East, 1967, Arthur Pieman 2002/03, and recently, Dunalley 2013). Significant also are the Brindabella Ranges fire in the Australian Capital Territory/ New South Wales 2002/03 and the New South Wales coast fires in the same year. In the 2013-14 fire season, New South Wales also responded to several disasters during the year, with the bushfires of 16–23 October (in 2013) causing major destruction. This included damage to over 300 homes,

primarily in the Blue Mountains, west of Sydney. Bushfires throughout the state resulted in 18 evacuation centres opening, with 3458 people registered with those centres (as reported by the Steering Committee for the Review of Government Service Provision, 2015, p.9.78).

For the reasons outlined, because of the relatively high incidence of bushfire in Victoria, this state was selected as the major focus for study in this dissertation.

1.1.2 Climate change and the urban interface

Also evident is the likelihood of some parts of Australia facing more serious fire conditions in the future, due to the impact of climate change. The Commonwealth Scientific and Industrial Research Organisation (CSIRO, 2010) indicated that:

With the likely onset of climate change effects, modifications to aspects of the Forest Fire Danger Index (FFDI), particularly the assumptions regarding the rate of fuel drying, should be considered to better reflect the change in drying conditions in future. Under climate change it is expected that current 'windows' for hazard reduction burning will change and possibly narrow, meaning less opportunity to conduct safe and effective hazard reduction burns. (Select Committee, 2010, CSIRO, Submission 15, p. 50.)

In other words, more days will be conducive to catastrophic fires occurring and there will be fewer days in which to mitigate their effect through prescribed burning. In the words of Bartlett, Leonard & Morgan (2007):

Large devastating forest fires have become an increasing phenomenon in both Australia and the United States of America (USA) over the past decade. Four kinds of wildfires are generally acknowledged to define the spectrum of suppression operations: Initial attack fires; extended attack fires; large fires; and Mega fires. These wildfires transition along a

continuous spectrum that runs from very small, short duration and non-complex to extraordinarily large, long duration and very complex (p.1).

The *megafire* category fits several of the recent fires in South East Australia and with the influence of climate change the potential for more such uncontrollable fires is apparent. In short, the concept of a ‘normal’ bushfire season is rapidly changing as bushfires continue to increase in number, burn for longer and affect larger areas of land (Bushfires and Natural Hazards Cooperative Research Centre, 2014).

The problem is exacerbated by the expansion of towns and cities over recent decades, accompanied by much decentralized human settlement in forested areas. The urban/rural interface has increased so that fires in the bush are much more likely to impinge on human settlement (see for example, Buxton, Haynes, Mercer and Butt, 2011). The close interface between the city of Hobart, in the state of Tasmania, and its surrounding forest areas, for example, has the potential for huge devastation, as demonstrated in 1967.

1.1.3 Fuel reduction burning

The value of “prescribed burns” as a precautionary strategy to reduce the quantity of surface fuel is a frequently debated topic but the findings of various bushfire inquiries are strongly in favour of the strategy. A recent senate inquiry (Select Committee on Agricultural and Related Industries, 2010) found demand for a major increase in the level of prescribed fuel-reduction burning. Various other inquiries have reached similar conclusions and the Parliament of Victoria’s *2009 Victorian Bushfires Royal Commission* recommended a three-fold increase in the scale of prescribed fuel-reduction burning, that:

The State fund and commit to implementing a long-term program of prescribed burning based on an annual rolling target of 5 per cent minimum of public land (Recommendation 56, p.3).

However, the Senate Inquiry (Select Committee, 2010) identified several problems facing the industry’s ability to respond to this demand for increased hazard reduction and, this was also noted by Bartlett, Leonard & Morgan (2007).

Notwithstanding past experience and more recent research, the areas treated with prescribed fire in most southern Australian jurisdictions have fallen considerably in recent decades [...]. There are several reasons for this including: the resources and skills available to land management agencies; the dramatic growth of built assets in the urban interface; the risk averse nature of land management agencies; and political and community attitudes to fire (p. 8).

1.1.4 The shifting skills base in fire management

While the hazards of catastrophic bushfires in Australia are likely to increase and it has been estimated that the number of professional bush fire-fighters will need to double by 2030 as compared to 2010 (Hughes & Steffen, 2013, p.49), there has been a decline in the number of personnel with bushfire management knowledge, skills and experience. There has also been a decline in the number of volunteer bush fire-fighters. This poses a major concern for future management and training strategies.

Land tenure shifts have greatly reduced the areas of commercial management in public forests to the extent that in most states there is a much-reduced proportion of production forests relative to parks, reserves and other areas. While production forestry has a commercial imperative to invest in the protection of its resource, state governments have generally declined in their commitment of resources to land management. Production forestry has been a major traditional source of expertise in fire mitigation, from forest workers and bulldozer drivers to forest managers. While in the past state forests were largely managed by foresters with bushfire experience, today they are being replaced by graduates in various forms of environmental science with shallower knowledge of fire behaviour.

The reduction in commercial forestry has been matched by a substantial decline in the number of undergraduates choosing to study forestry. Professor Kanowski estimated that only 30-35 students would graduate with a university forestry qualification in 2010, short of the 50-100 required (as reported in the Select Committee on Agricultural and Related

Industries, 2010). A decline in forestry research and study is also attributed to the closure of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Division of Forestry and Forest Products and the amalgamation of Australian National University and Melbourne University's forestry programs into broader faculties.

While academic training in forestry is on the decline, so are the opportunities for practical fire-training experience. Not only is there a diminishing window of opportunity for prescribed fuel-reduction burning, partly because of climate change but also because of increased regulatory obstacles to prescribed burning relating to native vegetation conservation and public concerns about smoke emissions. Roadside burns conducted by *Country Fire Authority*⁶ brigades as hazard reduction around local towns used to be a significant source of training for novice bush fire-fighters. However, today many local brigades are reluctant to undertake these activities because of the paperwork and protocols for traffic management, etc.

Another factor which inhibits the training of an effective fire management workforce is the reduced pool of suitable volunteers.

In the past, fire fighters were farmers, logging contractors and forestry workers with years of fire experience and accustomed to hard work. As more native forest areas have been withdrawn from forestry management and as farms have become bigger and more mechanized requiring less labour, the pool of physically fit, healthy and experienced fire fighters has diminished (Select Committee on Agricultural and Related Industries, 2010, Australian Forest Growers, Submission 16, p.4).

Declining rural populations, transient workforces, absentee land ownership and some other factors have also contributed to the reduced pool from which volunteers can be drawn.

⁶ The County Fire Authority is the largest bush fire-fighting organisation in the state of Victoria (Australia) responsible for defending bushfires in rural areas and regional townships of Victoria originating on private land, as well as the portions of the outer suburban areas and growth corridors of Melbourne not covered by the Metropolitan Fire Brigade.

Among others, the Senate inquiry (2010) expressed concern about Australia's future capacity to perform necessary bushfire management tasks in view of the declining skills base and volunteer numbers. It concluded the following:

Implementing adequate prescribed burning programs across fire prone landscapes will be very difficult to achieve in the future unless a declining skills base and volunteer numbers is addressed. We need to maintain depth of knowledge and practical experience of fire behaviour to ensure adequate prescribed burning will be possible, particularly on the public lands that now constitute an increased proportion of the landscape (p.130).

It expressed a need to maintain depth of knowledge and practical experience of *bushfire behaviour* to ensure that adequate prescribed burning will be possible, particularly on the public lands that now constitute an increased proportion of the landscape. This, the reports note, is a consequence of the increase in national park space from areas previously devoted to commercial forestry. To assist state land management agencies to achieve a sufficient pool of qualified people with practical bushfire training to meet this obligation, the committee (Select Committee, 2010), recommended the following:

The Commonwealth assist the states with bushfire training for land managers and volunteers by co-ordinating curriculum development and delivery of a national bushfire accreditation course, to be delivered by the relevant state agencies.

Such an arrangement would offer extensive qualifications tailored for full-time employees of land management and fire agencies, as well as minimal, flexible and subsidised options for volunteers. Courses would have a strong practical component, provided with the co-operation of state land management and fire agencies and their experienced personnel (pp.129 -130).

The next sections examine the broad challenges facing bush fire-fighting agencies in the effort to provide optimum training for both volunteer and career personnel.

1.1.5 Challenges to the training of volunteer and career personnel

Bush fire-fighting personnel comprise a spectrum ranging from part-time volunteers who operate the trucks, create the fire-breaks and fight the fires, directed in turn by more experienced crew leaders (which include volunteer bush fire-fighters) and career bush fire-fighters, to the professional land managers and decision makers whose expertise is required to encompass ever more sophisticated technical analyses (of remote sensing data, for example) as well as ecological and social considerations relating to bushfire.

Traditionally the progress from novice to expert has been via long years of experience in the field, assisted by the mentorship of more experienced personnel.

Historically bushfires were addressed by local volunteer brigades who sought assistance from other brigades, police, ambulance services, etc. on an ad-hoc basis. In time, the need for a more efficient level of co-ordination between various local and State fire authorities became increasingly apparent, along with the recognition that there are many other organisations including non-emergency services that have roles in managing fire incidents. Since 2003 all bushfire responses have been coordinated within the parameters of the management system known as The Australian Inter-Service Incident Management System (AIIMS), based largely upon the national fire response system adopted in the United States of America (AFAC, 2005, p.4).

Under this system an incident controller is appointed to establish the incident management framework, comprising the functions of control, planning, operations and logistics. Depending on the scale of the incident, these functions may be delegated to other officers who may, in turn, delegate components of their responsibilities to others. The system is flexible, allowing the creation of management teams commensurate with the scale and complexity of the situation.

First response on the fire-ground is at the level of the local authority which organises the available personnel into crews. These may include a large proportion of volunteer bush

fire-fighters trained only to the minimum level of readiness (which distinguishes Australia from some other countries). Deployment of additional human and physical resources and liaison with other agencies is at the discretion of the incident controller and team.

Response to the incidence of bushfire is fraught with uncertainty, as any given action or inaction has the potential for unforeseen outcomes. Interacting with such uncertainty involves an element of risk, with potential outcomes ranging from property damage to injury and fatalities within the workforce and/or the community. The inter-agency management conducted under the AIIMS framework seeks to reduce risk by efficient co-ordination of all parties participating in the overall response. This complements the efforts of the various bush fire-fighting agencies to minimise risk through the competency-based training of personnel established under the national *Public Safety Training Package*. The basis for this curriculum is examined in more detail in Chapter 4 but essentially the training addresses lists of minimum prescribed performance competencies applicable to each bush fire-fighting role, from volunteer crew member to incident controller. Workplace safety is a major focus for the structure of these competency hierarchies.

Whilst training provides scope to try to mitigate risk to workers, there is also a need for bush fire-fighting agencies to account for operational risks. Efforts for bush fire-fighting agencies to reduce risks has extended further than workplace safety. Another impetus for training has been the litigation which can arise from incidents when things go badly. If, for example, a decision is made (or not made) which results in damage to persons or property, the organisation may be required to prove in court that the personnel involved were adequately trained for the circumstance. It has been reported, for example, that the threat of such litigation may cause some land management agencies to become increasingly risk averse, for example, in the conduct of fuel-reduction burning (Bartlett et al; 2007, p.8).

These circumstances and legal pressures have increased the need for formal accreditation of training to national standards and national competency-based frameworks. However, several concerns have been raised about the problems of implementing the national training system. For example, Foster (2002) highlights some specific struggles:

With such large numbers of people, with a range of educational skills reflecting the full spectrum of Australian society, are our training programs really addressing the needs of all? Add to this the issue of the ageing profile of bush fire-fighters and experiential versus formal learning, the problem is magnified (cited in Hayes, Golding & Harvey, 2004, p.10).

At entry-level to training there may be novices from rural occupations with some practical capabilities but little educational background, many of whom may be challenged by formal teaching situations, alongside university-trained land management staff who may be quick to grasp theoretical constructs but devoid of practical experience of fire.

The inquiry conducted by the Council of Australian Governments (COAG, 2004), also noted that formal training under the competency-based Public Safety Training package has placed additional demands on volunteers. A study by Hayes et al (2004) found that there is resistance to the formal training of volunteer crews, especially in country and remote rural communities.

The introduction of more formalised training and assessment was found in our study to present challenges as well as opportunities to public safety volunteers. A number of volunteers, particularly those in older age groups, had left or were reconsidering their participation because of increasing demands being placed on them. There are a number of reasons for this, including a belief that the more formal approach to training is unnecessary and that prior learning, skills and knowledge developed over years of experience are not recognized appropriately. There is also evidence of concern related to the ability to successfully complete formal assessments because of literacy or other communication skills issues (p. 6).

Nevertheless, it is clear that the literacy, numeracy and ‘learning to learn’ demands on individual volunteers are going to increase, alongside the changing demands on the bush fire-fighter role and shifts in community expectations and legal pressures.

While the pool of suitable volunteers has diminished over recent decades, at the same time the pool of career bush fire-fighters with experience and high levels of knowledge and expertise is also diminishing with ageing and retirement. The increasingly complex demands of fire management in Australia are similar to those faced in the United States, where, “the duties of US fire professionals have become more complex and risk laden because of fuel load accumulation, climate change, and the increasing wildland-urban interface” (Kobziar, Rocca, Dicus, Hoffman, Sugihara, Thode, Morgan Vaner & Morgan, 2009). In response to these new pressures, the authors believe that the current educational and training regimes in the United States of America must change towards greater professionalism.

In light of the changing scope of fire management, the needs for professional staffing have rapidly expanded, outgrowing our current educational capacity and increasing demands for training. The types of education and training needed for future fire professionals have also evolved. In support of fire suppression, fire education has long focused primarily on fire as a physical process, on weather and fuel interactions, and on how to most effectively control fires (Gemmer 1980). With the increased recognition of fire’s role in sustaining ecosystems and mitigating future wildfire risks, focus has expanded to include fire ecology and ways to use fire as one of many applied biodiversity conservation and ecosystem restoration tools. Furthermore, fire management is increasingly technology intensive, so that fire professionals must be adept at interpreting and applying the results of analyses based on remote sensing, geographic information systems (GIS), and models to support decisions. (p. 340).

These, coupled with the domain knowledge required to manage land ecologically, increase the breadth of skill needed by fire managers. While referring to the demands upon fire managers rather than the basic bush fire-fighter roles, Kobziar et al (2009) also notes the following:

Just as graduates need to be able to apply GIS, remote sensing, fire behavior models, and other technology (Zhao et al. 2005), they need to be adept at balancing social, economic, political, and ecological considerations (Sample et al. 1999). Such “broad and deep education” (Fisher 1996) could be well complemented with skills learned on-the job through training and experience (p. 340).

In the Australian context, the ability to balance these new social, economic and ecological considerations as well as to work sensitively and effectively within communities is equally critical. On the level of responding to social change and greater professionalism, Childs’ (2006, 2005) research into social and industrial changes to the work of bush fire-fighters seeks a broadening of the industry’s internal labour market to more strongly reflect the diverse profile of the Australian community. Childs’ (2005) cites the difficulty of engaging with communities with a workforce that is socially unrepresentative, particularly with a striking under-representation of women.

Of the paid full-time bush fire-fighters within fire and rescue agencies within Australia today – on average, less than 5 per cent [are female] and in some states less than 2 per cent (p. 21).

Childs (2005) also identifies a need to include critical reflection as a core professional capability, especially for improving bush fire-fighters’ capabilities to participate in post-incident debriefings. She defines critical reflection as the ability to “scrutinise their professional conduct and the ethical dilemmas of their work” (p.566). The implication of her research is a call for a paradigmatic shift in the education of bush fire-fighters and she concludes as follows:

Instructional methods based on rote learning, chalk and talk, and show and tell training are insufficient as a means of developing bush fire-fighters capable of responding and adapting to the complex demands implicit within increasingly professionalized firefighting labour (p. 566).

The need for more integrated training programs for career fire managers at the tertiary level was also a key finding of the COAG (2004) investigation, as follows.

Most university education about bushfires focuses on particular aspects such as fire ecology or land management. There are few programs that deal with bushfire mitigation and management as an integrated whole (p.105).

Kobziar et al (2009), while advocating similar “integrated” tertiary educational programs, also points to the value of integrating tertiary education with work-based training and experience as a way of addressing shortcomings in “the current fire professional development paradigm” (p. 340). In this way, effective training and on-the-job learning experiences are integral to the development of professional employees with university qualifications in land management, forestry and ecology disciplines.

Several enquiries (e.g. The Council of Australian Governments - COAG, 2004 and the two inquiries referenced above) identify training to be fundamental to building the capacity to respond to the challenges raised above, both for bush fire-fighters and others who have fire management roles. They have all recommended increasing resources for the training of volunteer bush fire-fighters, career bush fire-fighters and land managers. The COAG enquiry (2004) identified several obstacles to be overcome. These included making the transition from curriculum-based training to a competency-based system, involving the enormous cost of providing minimum-competency training to the large number of volunteers across Australia⁷ and the need to overcome volunteers’ reluctance to

⁷ There are an estimated 220,000 volunteer bush fire-fighters (McLennan & Birch, 2005) and over 30,000 career bush fire-fighters (AFAC, 2013) in Australia.

sacrifice additional time for formal training. The report also alluded to some cultural barriers within bush fire-fighter organisations which may impede the development of a learning culture, with consequent implications for the provision of training.

1.1.6 Implications for training and education

To meet the challenges outlined above, Australia needs a well-equipped, well-trained workforce to respond to the increasing threat of intensive bushfires. Over recent years there has been a shift in the skills base needed to respond to this challenge which makes the provision of effective training strategies and their on-going improvement through practice an issue of major importance. Workplaces have been traditionally important sites for learning, with apprenticeships forming a core role for practitioner development in many occupations. In Australia, this has been the case for bush fire-fighting, with rural workers, particularly forestry and farm workers, acquiring the skills needed by learning on-the-job alongside more experienced workers. In the past, these were often “jobs-for-life” and workers would build their bush fire-fighting skills over many years. However, as noted above, the decline in rural industries and the need to build greater bush fire-fighter numbers means that fewer recruits are drawn from this traditional source and past approaches to developing skills on-the-job and over time may not be sufficient.

This situation, and the need to secure public safety and improve bush fire-fighters’ skills, has led to improvements in basic bush fire-fighter training as well as making this training more universally available. In this respect, the adoption of competency-based basic training for bush fire-fighters has arguably lead to numerous benefits. However, as noted there are a range of challenges to training. Providing learning opportunities that cater to trainees across the spectrum of prior experiences, skills, attitudes and knowledge and providing ways to heighten trainees’ engagement in learning are among the difficulties noted. Training must also cater to professional employees with university qualifications in land management, forestry and ecology disciplines who may have limited formal study of *bushfire behaviour* or practical experience of bush fire-fighting.

Also, reported above is the need for a broadening and deepening of the bush fire-fighter knowledge base. For example, the Senate inquiry (Select Committee, 2010) draws the conclusion that in order to provide for the future capacity to perform well, it is necessary to maintain a depth of knowledge and practical experience of *bushfire behaviour* across this workforce. This inquiry also expressed concerns about the future capacity to perform prescribed burns as well as provide the emergency response needed for uncontrolled bushfires.

It should be noted that this thesis seeks to investigate the nature of current training practices within this overall context, with a particular focus upon entry-level training and the core curriculum that underpins this training for bush fire-fighters employed within a local land management agency. The next section outlines this focus before introducing concepts and theories important to the study.

1.2 The focus of this study – the problem of training bush fire-fighters

As shown above, the Australian continent contains vast areas of forested fire-prone land, tenured by a variety of land management agencies. We have seen that South-Eastern Australia is one of the most fire-prone regions of the world and that the State of Victoria has experienced the highest incidence of severe bushfire events. It was decided therefore to choose Victoria as the focus of this study.

The response to bushfires in Australia is undertaken by three broad entities - the individual land management agencies, the city-based, professional fire brigades of State fire authorities and the subsidiary rural fire brigades, comprised largely of volunteer bush fire-fighters. The changing make-up of the bush fire-fighting workforce has been discussed. The reduction in commercial forestry has depleted the pool of forestry managers and workers with bushfire experience, while the mechanisation of agriculture has reduced the pool of rural volunteers. In land management agencies – the focus of this study - training cohorts now include well-educated urban agency employees with little or no bush experience, alongside minimally educated rural workers who are more “bush-savvy” but who struggle with communication and complex protocols.

Land management agencies operate under a broader ethic in that their stewardships embrace various management issues, of which the responsibility to mitigate bushfires is only a component. Personnel employed to undertake fire mitigation roles include those who have full-time dedicated roles as fire managers responsible for specific regions but also staff normally occupied with other tasks who are transferred to fire-mitigation roles when circumstances demand. The agencies also employ a large contingent of seasonal bush fire-fighters to meet the demands of the bushfire activity during the peak fire season. It is important they are well-trained and equipped to do this. The main land management agency with a major role in bushfire response in Victoria is the Victorian Department of Environment, Land, Water and Planning⁸ and its bushfire training program was selected as the subject for the following investigation.

Having decided upon the training adopted by a fire management agency in Victoria as the locus of study, it was also decided that the instruction concerning *bushfire behaviour* should be the major focus, for several reasons. First, as we have seen, this was a primary concern voiced in the conclusions of the governmental inquiries quoted previously. Second, understanding bushfire behaviour is a critical component of the bush fire-fighter skill set and a core element included in entry-level training. A preliminary review of the curriculum, to be analysed in detail in subsequent chapters, showed that *bushfire behaviour* was likely to be the most cognitively demanding aspect of the curriculum, particularly for novices. An understanding of *bushfire behaviour* underpins all aspects of the bush fire-fighter's role, whether at the level of foot-soldier on the fire-ground or incident controller deciding what, where and when resources should be deployed. Moreover, the initial training included in this study is all that is required for entry-level fire-fighters to perform on the fire-ground. How this instruction is enacted during entry-level training could be expected to provide important insights into the effectiveness of training overall.

⁸ At the time of this study, the agency was entitled as The Department of Sustainability and Environment

1.3 Introducing key concepts and theories important to this study

Learning in the workplace has been generally assumed to consist of a formal, structured sequence of instruction directed towards codified endpoints such as the performance of specific tasks or roles within an organisation (Billett, 2004). This assumption is embodied in the Australian Government's *national training reform agenda* and subsequently reflected in the codification of *competency-based training packages* such as that which presently forms the basis for entry-level training for volunteer and career bush fire-fighters. Novices are instructed in the performance of practical tasks (including the operation of bush fire-fighting equipment) and theoretical concepts (such as *bushfire behaviour*). The trainees are tested and their competencies and knowledge assessed. The learning which occurs may be defined as *accredited learning*.

However, as more recent studies have sought to investigate, learning also takes place through participation in everyday workplace practice, through the performance of tasks alongside other workers and/or under the guidance and supervision of more experienced personnel (Slade, 2013; Sommer & Nja, 2011; Taber, Plumb and Jolemore, 2008; Lloyd & Somerville, 2006). This is often referred to as *informal learning*, though some observers object to this term because it implies an ad-hoc, unstructured, *not-formal* learning. Billett (2004) asserts that this negative bias derives from a common assumption that educational institutions are the important venues for learning, a bias which overlooks the fact that *informal* or *on the job learning* in many workplaces provides access to activities that are "often intentionally organised to structure workers' access to the knowledge needed to learn to sustain those practices" (p. 315).

This points to a broader conception of learning as *situated learning* which arises from the individual's participation in social practice, through engagement in the work activities, with access to support and guidance. Lave and Wenger (1991) defined learning as engaging in the changing processes of participation in *a community of practice*. How workplaces provide opportunities to engage in work, the kinds of tasks individuals are permitted to participate in and the guidance provided are keys to understanding and evaluating how novices learn and subsequently develop their vocational practice (Billett,

2004). It follows that the workplace culture, its norms of interaction, methods of practice (rules and routines), identities, divisions of power and the way it assesses and rewards performance is a major influence upon the nature of the learning, which may either support or frustrate the participant's progress. Thus, workplaces can also be contested environments and awareness of these and other related social facets of participation is important to the enhancement of these *workplace participatory practices* (Billett, 2004).

However, in addition to revealing a deeper set of social relations that give structure to learning, it is argued that it is through engagement in the circumstances of work that individuals learn and that it is these very situational factors that can influence the knowledge that individuals construct (Billett, 2001). In this way, individuals learn *through* work, and an understanding how social tools are used to enact, transform or remake circumstances provides insights into an individual's capacity to learn to perform. These are defined as a *pedagogy of practice* - the activities and interactions that comprise what individuals will encounter and from which they learn (Billett & Smith, 2014). Thus, knowledge is conceived as being embedded in the domains of activity (social practice), and how those tools are enacted in particular circumstances and activities is another facet to understanding how capabilities and expertise are formed.

Cognitive tools, such as the critical thinking skills which can adapt to rapid changes of circumstance, play a significant role in non-routine problem-solving and an understanding how these tools are used in complex activity will also contribute to an understanding of what constitutes the *pedagogy of practice* (Billett & Smith, 2014). Thus, cognitive activity signifies a second and equally important domain of activity. Responding to rapidly changing, non-routine situations is becoming an increasingly important component of bush fire-fighter skill.

Thus, understanding about how learning contributes to the developing expertise, requires an understanding of how these combined cognitive and social tools are enacted in practical circumstances and activities (Billett, 2001). Conversely, an understanding of how these two primary domains of activity constitute practice will provide a more comprehensive account of how learning occurs and might be improved.

As the interaction of cognitive and social tools are unique to each domain of practice, it is important to examine how they affect learning on a domain by domain basis. In the bush fire-fighter's domain, contributions from the cognitive view of expertise are useful for understanding and identifying the attributes required for thinking performance. A review of the studies which bring these factors to light will be examined in the following chapter. However, they provide only limited understandings of how knowledge is sourced. Contributions from the situated learning and other social-cultural perspectives, provide additional understandings about the social and cultural factors which impinge upon workplace learning. In the following chapter, research is examined which demonstrates the critical role that participatory practice plays in structuring learning, theorized as *legitimate peripheral participation* in a community of practice (Lave and Wenger, 1991). While it will be shown how it relates to bush fire-fighter practice, this research offers limited understanding about individual learning in relation to crisis and non-routine action in complex situations. These problems are examined in the following chapter in the light of pertinent contributions from expertise, situated and social/cultural learning literature which also provides important concepts for understanding the implications of this study.

Concepts from cognitive psychology and social/cultural learning theory will be employed to contribute to understandings of how bush fire-fighters learn, the activity that constitutes that learning and how instructional experiences can engender key bush fire-fighter knowledge and skill. The following section outlines the research aims and questions, followed by an outline of the thesis structure.

1.4 The aims of this study and the research questions

Within the broad context of the increasing demands faced by Australian bush fire-fighting organisations and the increased demands and responsibilities on the bush fire-fighter skill base, the focus of this thesis is on how the core bush fire-fighter curriculum is preparing bush fire-fighters for this work. This thesis aims:

- To investigate what underpins the curriculum for bush fire-fighters, to examine the challenges of organising and delivering the curriculum and its core learning goals within a land management agency;
- To examine the trainees' perspectives and experiences of the entry-level training context;
- To examine the perspectives of trainers towards the training curriculum and its delivery;
- To examine the way educational strategies are employed to help learners understand the theoretical concepts of bushfire behaviour, via a traditional approach and an alternative delivery based on simulation.
- To understand the ways in which the simulation approach addresses the challenge of providing learners with an understanding of bushfire behaviour.

To meet the aims of this study, the following research questions will be addressed;

1. How are bush fire-fighter learning goals for entry-level bush fire-fighting currently organized in the curriculum and what are the challenges in delivering this curriculum?
2. What are the perceptions of trainees about learning bush fire-fighting?
3. What are the perceptions of trainers about how trainees learn bush fire-fighting?
4. How is the teaching of the science of bushfire behaviour currently enacted in the learning environment?
5. What are the affordances of a situated immersive pedagogy in teaching the science of bushfire behaviour?

1.4.1 Summary of the process of the research

There were two main phases to the data collection and analysis. The first phase investigated the bush fire-fighter curriculum and the conduct of a typical entry-level bush fire-fighting training program. The case chosen focused upon multiple deliveries of an entry-level bush fire-fighter course which was being conducted by the Victorian land management agency. This course, the *General Bush fire-fighter course*, is an intensive

five-day course conducted for different cohorts at various camp facilities in Victoria. The review of the training course included observations conducted at three separate training camps as well as semi-structured interviews involving 22 trainees and 12 trainers. A survey, an analysis of course-work and learning outcomes was also undertaken at this stage. These processes will be discussed in detail in Chapter 3.

The second phase examined in more detail how the theoretical component of understanding bushfire behaviour was taught, using two different pedagogical approaches to the conduct of training, one using a standard lecture-style delivery typical of the way this theoretical component has been taught and the second using an approach employing a *simulation fire-table*. The second approach was being introduced for the first time in entry-level bush fire-fighter training.

1.5 Thesis outline

Chapter 2 - provides a review of the literature relating to expertise and the problem of learning for the workplace.

Chapter 3 - provides a description of the methods used to reach the goals of the research.

Chapters 4 – 8 outline the findings. These are summarised in Table 1 (on page 29) which indicates the aims of each chapter, the methods of investigation and the research questions addressed.

Table 1: Map of findings chapters across the aims, methods and research questions

Findings Chapter	Aims	Methods	Research question
Chapter 4	To investigate what underpins the curriculum for bush fire-fighters, to examine the challenges of organising and delivering the curriculum and its core learning goals.	Examined curriculum documents; Demographic data collected via surveys and via agency's database; Trainer interviews, including observations and interviews conducted at curriculum review sessions.	RQ 1: How are the learning goals for entry-level bush fire-fighting currently organized in the curriculum and what are the challenges in delivering this curriculum?
Chapter 5	To examine the trainees' perspectives and experiences of the entry-level training context.	Interviews conducted with trainees; trainee surveys.	RQ 2: What are the perceptions of trainees about learning bush fire-fighting?
Chapter 6	To examine the perspectives of trainers towards the training curriculum and its delivery.	Interviews conducted with trainers; observations of teaching practice during three General Fire-fighter training camps; interviews and observations conducted at curriculum review meetings.	RQ 3: What are the perceptions of trainers about how trainees learn bush fire-fighting?
Chapter 7	To examine the way educational strategies are employed to help learners understand the theoretical concepts of bushfire behaviour, via a traditional approach and an alternative delivery based on simulation.	Detailed observation and recording of two exemplar deliveries of this component of the curriculum, one using the traditional lecture approach and the other using a simulation-based approach.	RQ 4: How is the teaching of the science of <i>bushfire behaviour</i> currently enacted in the learning environment?
Chapter 8	To understand the ways in which the simulation approach addresses the challenge of providing trainees with an understanding of bushfire behaviour.	Collation and analysis of the affordances of the simulation-based approach, in the light of educational theory.	RQ 5: What are the affordances of a situated immersive pedagogy in teaching the science of <i>bushfire behaviour</i> ?

1.6 Conclusion

Fire in the Australian landscape is an increasingly threatening phenomenon, placing increasing pressure on fire and land management agencies faced with a declining skills base and the need to recruit and train a larger workforce of volunteer and career personnel. Government inquiries have called for increased levels of fuel reduction burning and improvements to bush fire-fighter training to meet the challenges. Moreover, bushfires are becoming more intense and bush fire-fighter work is becoming potentially more hazardous. Australian bush fire-fighters need critical skills to meet these changing circumstances and increased demands. It is therefore important to examine the nature of bush fire-fighter expertise and the learning which underpins it.

Also highlighted is the need to provide better education and training. The growing diversity of recruits raises questions about the viability of traditional approaches to provide the widening and deepening of the skill base Australian bush fire-fighters need.

Chapter 2

Literature Review

The study of learning in the workplace has become an important activity for educational theorists in recent decades. Engagement in work activities that offer rich learning experiences are now increasingly discussed as is the need to enhance the quality of learners' engagement in workplace learning. As in-service training has become increasingly adopted by industries and service organisations as a major component of their workforce skilling, the incorporation of these rich “work-like” experiences in training is becoming a legitimate means for addressing the requirements of individual learning and the development of the capacities required for effective work practice (Billett, 2011). To these ends this thesis is particularly focused on research examining practice-based pedagogies with a specific interest in pre-service curriculum and training approaches.

The themes contained in this literature review have been selected from a range of disciplines on learning and workplace pedagogy and were selected based on their relevance. This meant my search was not limited to research and theoretical development covering the last few years.

There are three sections to follow:

Section 1 examines the cognitive constructivist literature. Constructivist learning perspectives reveal the value of knowledge acquired by cognitive understanding of underlying principles, which allows for generalization and transferred application to new situations.

Section 2 examines the situated learning literature which views learning as something which best occurs through participation in the practice of the workplace, during which knowledge and skills become subjectively embodied rather than simply remembered as

abstract concepts. This includes an examination of research into the nature of bush fire-fighter learning and expertise through training and workplace participation.

Section 3 examines contributions from the cognitive psychology “expertise” literature which are useful for understanding and identifying the attributes required for expert performance. This literature shows that a strong foundation of knowledge is critical to skill formation. The research also demonstrates the centrality of applying foundational knowledge flexibly, in diverse performance situations.

2.1 Constructivist learning perspectives

Of the various assumptions about how people learn, a major theoretical perspective that has currency in educational domains is the constructivist theory of learning, which encompasses broad-based perspectives that have evolved from a long tradition within the discipline of psychology. This theory aims to explain what knowledge is and how it is acquired, with the focus on how learners individually and socially construct meaning. In this perspective, learning is perceived as the individual’s active attempts to make sense of the world. Additionally, “a key element to the learning process is the knowledge the individual brings to the learning situation. Knowledge is the outcome of learning which guides new learning – thus what we already know determines what we pay attention to, perceive, remember and forget” (Woolfolk, 2010, p. 326).

Building on earlier traditions, the cognitive constructivist perspectives focus on developing theoretical understandings about how the learning of complex cognitive processes may occur. Judd (1908), for example, conceived the notion of developing higher mental processes. In this view the deliberate teaching of general principles is a means for learners to obtain: “a level of abstract, generalized, [and] conceptual understandings” (Judd, 1936). For Judd, it is these generalized insights which learners can make use of in new situations. Further research undertaken by Gestalt psychologists (e.g. Katona, 1940; Wertheimer, 1959; Koffka, 1935) substantiated and expanded these propositions about learning and transfer of learning. On the level of deeper learning, Katona (1940), for example, conceptualizes learning as the meaningful acquisition of the

principles underlying a certain problem or domain and proposes that providing (and finding new) methods of teaching and learning which encourage problem solving and building mental schemata, will lead to deeper learning (Saljo, 2003). This focus is on the interplay between what is learned (basic principles) and how it is learned (learning mechanisms); “learning tasks which emphasized learning with understanding (i.e. identifying the principles underlying the solution of various problems)” and on learners actively reconstructing principles through problem solving (Saljo, 2003, p. 314).

Katona’s (1940) research found that “the knowledge acquired through understanding is retained for longer periods of time without substantial deterioration” and these studies, alongside others in this tradition, provided empirical evidence “for the transfer of general principles from one situation to another” (p.245). As for Judd, it is these generalized insights which learners can make use of in new situations. In this view the notion of transfer focuses on the transition of knowledge across tasks - that is “the transition of knowledge used in one task to solve another task” (Tuomi-Grohn & Engestrom, 2003, p.33). This argument maintains that there is a close relationship between understanding a concept and being able to transfer that knowledge (Shepherd, 2000, p.11). Here the method of teaching and the processes of learning are critical to what is learned and should provide opportunities for the learner to specifically focus on the concept to be learned, with attendant opportunities for the learner to make important connections. Fundamentally this is about aligning the principle to be learned with its applicability and providing opportunities for learners to reconstruct problems.

Contemporary perspectives emerging from cognitive constructivist traditions focus on information processing and symbol schema theories, which have expanded our conceptions of how information is processed, represented and organized in memory and how higher cognitive skills and practices might be developed (e.g. Gagne, 1965; Bruner, 1961; Windschitl, Thompson, & Braaten, 2008). The cognitive perspective of schema construction, for example, has progressed our understanding of how different categories of knowledge, especially higher order categories like concepts and principles, are progressed through various learning approaches. This is known as higher order

declarative knowledge and Bloom's taxonomy (1956) is widely used device for representing the range of qualities of learning outcomes from lower order to deeper declarative learning objectives.

Accordingly, didactic arrangements based on these theoretical perspectives focus on developing cognitive principles, with the aim of supporting students to be "more adept at constructing understanding on the basis of general ideas and relations between concepts" (Greeno, 1998, p.14). Specifically, this could entail, for example, providing deliberate teaching and learning processes to help elaborate the learner's conceptual structures (schema), including examination of these schema with the learners and introducing new elements into conceptual structures. Essentially this is to make the model (the concept) as well as its various abstractions and generalizations much more transparent and, indeed, the object of the learning. Thus, the didactic concerns in these learning settings shift towards a focus on learners building upon their prior understandings or knowledge structures with the incorporation of metacognition (learning about the model) and reflective practices (individuals reflecting on their progress) (Schon, 1983, 1987) as critical factors within the learning environment.

The idea here is that learning is a process of knowledge construction, as opposed to knowledge recording or absorption (Resnick, 1989) and the importance placed upon *learning with understanding*, developing strong mental models and symbol-based reasoning, provide important theoretical underpinnings about the problem of learning. These precepts are also foundational to some of the research into understanding expert knowledge which characterizes expertise as the command of highly structured and well organized knowledge (i.e. advanced schema patterns). Taken together the ideas of *learning with understanding*, the *transfer* of abstract ideas across situations and the need to incorporate *reflective learning practices* are important to understanding how bush fire-fighter training may provide opportunities for learners to understand the deeper principles of the science of *bushfire behaviour* and make critical decisions in relation to these principles across the range of situations they might encounter.

Whilst these concepts provide important explanations to understandings about learning processes, several concerns have been raised about whether cognitive constructivist theories alone can provide an adequate understanding about learning in vocational practice and how work knowledge is structured and accessed.

First is the concern that this perspective underplays the important role that *participation* in social and physical contexts plays in the development of expertise. Studies into *situated and social learning processes*, as well as more contemporary perspectives of *cognitive expertise*, demonstrate the importance of workplace contexts, social relationships and the demands placed on practitioners in the formation of expert knowledge and practices.

Secondly, Engeström (2004), for example, raises concern that cognitivist explanations are “grounded in assumption of individualism, i.e. the individual as autonomous learner”, and argues that expert development does not rest on the “acquisition of stable and codified bodies of knowledge and skills” (p. 51). This challenges the notion that domains of work knowledge consist of objective, absolute truths and much current literature highlights the dynamic and situated nature of domain knowledge.

Thirdly, Engeström (following Lave and Wenger, 1991), also argues that “skills, knowledge and competence reside in local communities, not in transportable [school-like] packages” (Engeström, 2004, p.147). Others raise the issue of *inert knowledge* (Whitehead, 1932), asserting that in real-life problem-solving situations people often fail to apply knowledge previously acquired in formal learning because the decontextualized information was stored as facts rather than tools. They point to the interdependence of situation and cognition.

2.2 Situated learning perspectives

As more recent studies have sought to investigate, learning also takes place through participation in everyday workplace practice, through the performance of tasks alongside other workers and/or under the guidance and supervision of more experienced personnel (Slade, 2013; Sommer & Nja, 2011; Taber, Plumb and Jolemore, 2008; Lloyd & Somerville, 2006). This points to a broader conception of learning as *situated learning*

which arises from the individual's participation in social practice, through engagement in the work activities, with access to support and guidance. The theory of social learning (Lave & Wenger, 1991) was drawn from the ethnographic studies of Jean Lave (1991) and previous formulations of learning as a social and cultural activity, such as those of Vygotsky (1978). Its key propositions mark a major shift in thinking about learning and have formed the basis for a range of reformulations of our understanding of learning in the workplace. These include several models of learning derived from these premises, including *situated cognition*, *distributed cognition* and *cognitive apprenticeship*. Two key findings of the earlier social learning studies are particularly relevant here - that workplace communities play a significant role in shaping learning and that learning is arranged around a master/expert.

That workplace communities play a significant role in shaping learning, provides evidence of learning as a social process (Lave, 1991; Lave and Wenger, 1991). Earlier studies examined learning processes in real world activities, finding that social and physical contexts play a significant role in learning (e.g., Carraher, Carraher, & Schliemann, 1985; Lave, 1988; Scribner, 1984). Learning, in this view, is "an activity that takes place among individuals, the tools and artefacts that they use, and the communities and practices in which they participate" (Greeno, Collins & Resnick, 1996, p. 20). The communities and its practices are all encompassing and "individuals learn *as* they participate by interacting with the community (with its history, assumptions and cultural values, rules, and patterns of relationship), the tools at hand (including objects, technology, languages, and images), and the moment's activity (its purposes, norms, and practical challenges)" (Fenwick, 2001, p. 38). Thus, it is through participation in these communities, and the *situated learning* processes and activities in which these communities are involved (known as the *communities of practice*), that the critical processes for learning are afforded.

Lave and Wenger (1991) consider that in the right context the individual learner is not simply gaining a discrete body of abstract knowledge to be transported and reapplied in later situations but is acquiring the skill to perform by actually engaging in the process, under the conditions of *legitimate peripheral participation*. They view *legitimate*

peripheral participation as the mode of engagement of a learner participating in the actual practice of an expert but to a limited degree and with limited responsibility for the ultimate outcome. Lave and Wengers' concept of *legitimate peripheral participation* provides an important frame to view the central problem of developing expertise in different types of learning contexts and related questions about the processes and conditions of learning.

Legitimate peripheral participation, then, presents a broader concept of workplace learning than is encompassed by traditional theories of learning, which tend to focus on a linear acquisition of mental concepts. From the viewpoint of legitimate peripheral participation, "expertise" is the product of "full participation" which arises from active engagement over time in the socio-cultural environment of the workplace community. However, in addition to revealing a deeper set of social relations that give structure to learning; it is held that it is through engagement in particular circumstances of work that individuals learn and that it is these very situational factors that can influence the knowledge that individuals construct (Billett, 2001). Thus, an understanding how social tools are used to enact, transform or remake circumstances provides insights into an individual's capacity to learn to perform.

As foregrounded in the previous chapter, these are defined as a *pedagogy of practice* - the particular activities and interactions that comprise what individuals will encounter and from which they learn (Billett & Smith, 2014). Therefore, knowledge is conceived as being embedded in the domains of activity (social practice), and how those tools are enacted in particular circumstances and activities is another facet to understanding how capabilities and expertise are formed. This includes cognitive tools, such as the critical thinking skills which play a significant role in non-routine problem solving. Accordingly understanding about how learning contributes to the developing expertise, requires an understanding of how these combined cognitive and social tools are enacted in practical circumstances and activities. This type of investigation requires an examination of the detailed processes involved in learning. Of particular pertinence here, is how these practice pedagogies are being utilised in instructional settings, particularly when using

immersive learning contexts like simulations. The use of simulations as learning resources is becoming more prevalent and their potential to mimic aspects of practice, particularly the circumstances and activities of practice settings, makes them very useful in vocational education (Rush, Acton, Tolley, Marks-Maran, & Burke, 2010). At some level, it could be said that underlying the use of these learning resources is an aim to replicate aspects of these day-to-day pedagogies.

On this level, Brown, Collins & Duguid (1989), propose that access to real-life standpoints are imperative in that they give individuals access to what it takes to be able to act meaningfully and purposefully; this they argue is because "situations might be said to co-produce knowledge through activity" (Brown, Collins & Duguid, 1989, p. 32). Rogoff and Lave (1984) also propose that "individuals' thinking and acting is structured by the activities they engage in, which thereby influences what is learnt and what is redeployed in other activities" (as cited in Billett, 1998). Thus, from this *situated activity* perspective, it is argued that learning occurs through activity which mediates a myriad of contextual/practice factors.

On this, Rogoff (1995) prefers the term appropriation than knowledge internalisation as this suggests the passing of external knowledge, intact, from the outside to the inside, whereas appropriation is premised on individuals actively interpreting externally sourced knowledge and "gaining facility in an activity" (Rogoff, 1995, p.15 as cited in Billett, 2001). This suggests mediational processes at the interpersonal level as a more central concern in any analysis of learning as well as accounting for learning as a more dynamic and fluid component of these interactions and actions.

In addition to a focus on these micro-social learning processes, Rogoff (1984) emphasises the importance of goal-directed activity and problem solving within learning environments. These should include incorporating 'the problem's physical and conceptual structure as well as the purpose of the activity and the social milieu in which it is embedded' (p. 2). This implies that a major focus for teaching should be the provision of learning contexts that afford learners more meaningful participation in the activities and practices of the community.

The emphasis in work and practice-based learning contexts, then, should be towards improving a learner's "ability to participate meaningfully in particular practices (Fenwick, 2010, p.35)". On this level, Greeno (1998) characterizes, "improved participation" in an activity, as an important pedagogical goal. For Greeno such improvement "involves *becoming* better attuned to constraints and affordances of activity systems so that the learner's contribution to the interaction is more successful [my italics] (Greeno, 1998, p.12)". Greeno points out that this perspective shifts the framing assumption to the level of interactive systems and he prefers the term *knowing* over *knowledge* as it better depicts the sense of the processes involved in coming-to-know the regular patterns of participation within these systems (Greeno, 1997). He further elaborates that "when people learn to notice how specific properties and relations influence their possibilities for acting in one situation, they can more easily transform that activity in a wider range of situations (Greeno 1997, p. 37)". Therefore, attunement to the social, material and representational systems leads to a "generality of knowing" which Greeno argues is a more accurate description of how learning processes support participation across situations than the term "transfer of knowledge" depicts. Learning flows from forms of participation already embedded in practice, these *participatory practices* being key pedagogical devices where developing understandings of rich situational affordances are central.

This situated learning perspective underpins the studies of workplace learning examined in the following sub-section, which relates the major themes to bush fire-fighting and emergency service workplaces.

2.2.1 Studies of workplace learning in bush fire-fighting and emergency services

The concept of *legitimate peripheral participation* has framed several studies of workplace learning in bush fire-fighting and emergency service contexts. Taber, Plumb and Jolemore (2008) explored the interaction between organisational policies and daily work practices of paramedics and bush fire-fighters within two emergency response organisations in Canada. Sommer and Njå (2011) examined learning processes in Norwegian metropolitan fire brigades and Lloyd (2005) and Lloyd and Somerville (2006)

considered the different modalities of information and the relationship between workplace learning and professional identity in regional fire stations in New South Wales, Australia. Slade (2013) examined how novice police officers in rural Scotland develop expertise to act in emergencies. The following examines findings from these studies in relation to four qualities of *legitimate peripheral participation* as summarised by Billett (2001).

Firstly, Lave and Wenger (1991) consider “full participation in a community of practice” to be a more useful term than “expertise”. That is, the process of becoming a full participant requires learning social practice and access to and participation in the community’s activities, this in turn provides the basis for the understanding required for full participation (Billett, 2001).

This proposition underpins the study of Norwegian fire-fighting practice conducted by Sommer and Nja (2011), who found that:

New fire-fighters under mentor supervision (senior fire-fighters) become socialised into the existing culture. The aspirant fire-fighters model their own behaviour on that of the old-timers and they are inculcated with the workplace practice and working methods. This is a process whereby new fire-fighters move from the status of peripheral participants to becoming fully fledged members of the community (p.448).

Taber et al (2008) made similar observations in their study of the daily work practices of fire-fighters:

Some of what fire-fighters learn can be explicitly taught, but much is also learned in practice and through legitimate peripheral participation (Lave & Wenger, 1991). One officer stated that what they do is impossible to describe, and must be experienced personally to be understood. It is therefore very difficult to pass on these understandings to new fire-fighters. The ability to tackle problems and adapt is key, and the only way to adapt is through experience (p. 282).

Lave and Wenger's (1991) second proposition is that the appropriation of situationally relevant knowledge and skills requires engagement over time; during which, as Sommer and Njå (2011) observed; training, routines, exercises, responses to incidents, story-telling, discussions, lectures, courses, mentor supervision and informal interactions may all play a part.

Thirdly, they propose that full participation implies an ability to adapt to new situations and comprehend new understandings, which Billett points out is a hallmark of expertise for cognitivists (Billett, 2001). This quality is highly critical in emergency services such as fire-fighting.

However, while affirming the power of Lave and Wenger's theory of *legitimate peripheral participation*, Taber et al (2008) note a limitation. They argue that:

The notion of situated learning [...] offers little to help explain the dramatic performance of emergent, creative and autonomous actions often required of individual emergency personnel in crisis situations (p.273).

In this context, a fruitful enhancement of Lave and Wenger's *legitimate peripheral participation* proposition is the concept of *embodiment* of skills and knowledge, described, for example, in Sommer and Njå's paper (2011) as "getting the feel of it", or "getting it in the finger" as the Norwegian idiom puts it. On one level, this derives from repetitive training and experience so that behaviour becomes automatic but at the same time developing an ability to detect abnormal circumstances which may require actions other than the standard operating procedures. On another level, it relates to the accumulation of *embodied knowledge*, as defined by Lloyd and Somerville (2006):

Bush fire-fighters in the study identified the process of engaging with bodily information as developing "fire sense". The research identified that the body plays a central role in learning about actual workplace practice and gathering information about the nature of fires and signs of

danger. [...] Sensory information such as the loudness of fires, and the danger of quiet fires, using the physical senses to draw information about heat, provides learning experiences through which the bush fire-fighter develops fire sense (p.193).

On a similar note, but relating the role that *emotional knowledge* plays in learning, is the research Holgate and Clancy (2009) conducted into the bush fire-fighter's ability to appreciate and respond effectively to risk. They found that bush fire-fighters who had experienced a *threat experience* on the fire-ground – i.e. a potentially life threatening experience – were more likely to identify significantly more risks in response to fire-ground scenarios and reported a significant change in their approach to safety than bush fire-fighters who had *not* experienced a *threat experience*. They suggest that the “mechanism for this change is via an “affect heuristic” rather than rational cognitive analysis” (p.15).

Lave and Wenger's fourth component is the proposition that “individuals are defined by, as well as defining, their relationship with the social practice in which they participate” (Billett, 2001, p.15). In their view, *legitimate peripheral participation* “concerns the process by which newcomers become part of a community of practice” (Lave & Wenger, 1991, p.29). The novice bush fire-fighter, for example, enters a process of enculturation in the ethos, norms and protocols of a hierarchical social system. In his observations of structural fire-fighting activities, Billett (2008) noted that:

The workplace had sets of strict norms and practices that needed to be adhered to for work organisation and safety requirements. There were a range of mechanisms which reinforced this “command and control culture”, which included particular seating arrangements in the fire engine and a battery of permissions and regulations to which the officers were required to conform (p. 14-15).

Sommer and Njå (2011) noted a similarly hierarchical structure in the Norwegian Fire Service along with a strong preference for familiar and well-tried protocols:

It was considered to be both advantageous and correct to start “at the bottom” and then rise through the ranks. If a new fire-fighter is not willing to follow advice, suggestions and instructions given by more experienced fire-fighters, the novice is regarded as “having the wrong attitude” (p. 442).

Billett posits that “workplaces represent a socially constituted and contested learning space whose participatory practices are key pedagogical devices” (Billett, 2004, p.319).

Taber et al (2008) cite Wenger’s (1998) assertion that learning “is not just an accumulation of skills and information, but a process of becoming” (p.215) and note that:

As a fire-fighter related when discussing initial fire-fighter training, it is not simply technical skill training, but an introduction into the “culture of firefighting” whereby recruits become fire-fighters (p.274).

Lloyd and Somerville (2006) also portray this in their study:

Social information is intangible and is made accessible to probationers through discursive practices that reflect the community perceptions and experiences of practice and profession. These practices take the form of storytelling, deconstructing of critical incidents and past events, relating narratives on the institution and its practices. Information is sought and disseminated through casual and incidental communication and is influenced and mediated according to the beliefs, values and ideologies that drive a community of practitioners to support each other closely in practice (p.192).

As the above fire-fighter and emergency service studies demonstrate, the strength of *situated learning theory* is in its explanations about the learning structures embedded in practice. These studies provide insights into the learning frames of fire-fighters’ practices and how expertise develops within these social systems. However, some limitations of this theoretical perspectives can also be identified.

Hager (2011), for example, notes that this theory is “largely silent about the individual’s learning as their personal identity changes from that of novice to full participant (see, e.g., Elkjaer, 2003; Guille and Young, 1999)” (p.24). This is a concern for two of the “fire-fighter” studies considered above. Sommer and Njå, (2011) and Taber et al (2008) both question whether the notion of legitimate peripheral participation in a community of practice is a sufficient model for understanding learning in complex workplaces. For Taber et al (2008), whilst social learning theory provides the frame for their analysis of fire-fighter learning, as pointed out previously, they note that participatory frames may offer limited explanations for understandings about learning of crisis and non-routine action in complex, emergency situations occurs. They characterize crisis situations as ‘non-text book’ situations where “neither protocols nor prior experience offers ready solutions” (p. 273). Sommer and Njå, (2011), also argue that frontline safety depends both on routines learned through common practice as well as individuals’ abilities to problem-solve.

Frontline fire-fighters make decisions continuously throughout an operation in response to their commanders’ orders but also in accordance with their individual competence and situational awareness. To ensure self-protection and to optimize life-saving achievements and damage mitigation, the rescuers’ competence must span from automatic, skill-based behaviour to problem-solving, knowledge-based behaviour (p. 437).

This study finds that “personal experience (or *getting the feel of it*)” to a large degree is decisive for the fire-fighter to truly learn and change behaviour in emergency situations” and investigation into this *embodied knowledge* should be drawn into any analysis of learning for this workplace. Sommer and Njå, (2011) draw on individual cognitive aspects of learning to understand more about why bodily experience is a dominant learning mechanism. Their findings are supported by the expertise studies to be discussed later in this chapter.

Fire-fighters and commanders aim at developing the ability to quickly meet the needs of a situation, which primarily requires skills such as being able to adapt, rapidly discover the typicality of a situation and find an effective and sufficient way to cope. Abilities like these can be characterised as typical of experts (Dreyfus and Dreyfus, 1986; Klein, 2009) (p.449).

That the above studies attest to a more integrated and holistic skill set; for example, the embodied, emotional and social/cultural nature of the work knowledge of emergency workers, points to the complexity that is required of individuals in crisis situations.

In their study of information literacy in bush fire-fighters, Lloyd (2005) and Lloyd & Somerville (2006) concluded that there are three primary sources of information required for effective practice and professional development – textual sources, social sources and physical sources. Textual sources comprise training manuals, standing orders, safety bulletins, etc., which enable novices and bush fire-fighters to connect with institutional understandings of “practice, procedure and profession, which can be replicated and re-stated” (p.189).

Taken from this perspective conceptual knowledge, however, remains abstract until “actioned by the body or sanctioned as appropriate or valuable to practice by others embedded within the community of practice” (p.190). These social sources of information comprise a variety of discursive practices which reflect the community perceptions - storytelling, discussions of past events and critical incidents, etc. – in which experienced bush fire-fighters find themselves in a position to shape and influence novices’ understanding about bush fire-fighting practice, through mediating the information landscape and by affording information opportunities which connect the novice to the tacit sources of information.

Mentoring of novices by senior fire-fighters is a standard practice in the Norwegian service so that novices can learn by observing how the experienced fire-fighters work and

then doing things themselves under supervision. Taber et al (2008) noted the importance of mentoring within Canadian fire crews:

When there is an ideal mix of newcomers and old-timers, there are increased learning opportunities within the crew. Newcomers learn from old-timers and old-timers learn from mentoring the newcomers (Taber et al, p.282).

They note, however, that this ideal mix is becoming harder to achieve with the dilution of experience levels relative to the rapid growth of recruit intake. As examined in Chapter 1 there is a loss of experienced bush fire-fighters. This dilution of experienced personnel affects the mentoring capacity of bush fire-fighting organisations in Australia. Slade's (2013) study of novice police officers in remote locations relate a similar lack of novice access to expert mentoring.

The physical sources of information defined by Lloyd and Somerville (2006) are the embodied experiences which enable novices to acquire "fire sense" or get "the feel of it". This embodied knowledge can only be acquired through actual work experience in real situations. All fire services place importance on drills and exercises as a way of making actions automatic and to keep the body safe, but it appears that exposure to a variety of real fires is required to build the subtleties of "fire sense" (Lloyd and Somerville, 2006).

It is apparent from the preceding review that both the cognitive/constructivist and the situated learning perspectives provide useful insights into the nature of workplace learning. However, they also suffer from limitations in that they do not address the concept of expertise and how expertise develops in detail, an issue which is considered in the following section. This is important in workplaces such as the one under study, where the work increasingly involves complexity and higher order thinking.

2.3 The nature and development of expertise

A body of research within the discipline of cognitive science has focused on cognitive structures and processes that are typical of experts, providing evidence of the role

knowledge structures, memory, perception and problem-solving play in expert performance. Early expert studies focused on portraying characteristics of exceptional expertise, finding that experts' knowledge is highly structured and domain specific. For example, the research of De Groot (1946/1978), Simon and Chase (1973) suggested that chess players' expertise was derived from the ability to use their highly structured domain knowledge to perceive meaningful patterns; their extensive experience and accumulated knowledge of the domain enabled them compile a large repertoire of instances that they 'chunk' together as associated patterns of chess moves that have worked for them in the past (Simon & Chase, 1973). Their expert performance rested on their complex and situation-specific representations or mental models that are held in long term memory (Gobet & Simon, 1996).

Subsequent research has further developed the understanding of the nature of experts' knowledge representations. This research departs from earlier studies by adopting a more relative approach to understanding the dimensions of expertise (Chi, 2006; Ericsson, 2006; Ericsson, 1996; Klein & Hoffman, 1992). Two underpinning constructions of expertise are drawn from this body of knowledge as they are important to this thesis. First, because the approach taken in their research contrasts the proficiency of more advanced (or expert) individuals against those that are domain novices, it is assumed that expertise is a level of proficiency that novices can achieve. This stance provides scope to focus on how "expert" learning evolves along a continuum from novice to expert and essentially it assumes that expertise can be attained by all. Secondly, consequently, the definitions of the term "expert" and "novice" take on a more generic sense; in that "the more knowledgeable group can be considered the "experts" and the less knowledgeable group the "novices" (Chi, 2006, p.22). Thus, for example, the term novice "is used to refer to the range of non-experts within a field, from the naive [one who is totally ignorant of a domain] to the journeyman [an experienced reliable worker]" (Chi, 2006, p.22). This more generic sense of the terms "novice" and "expert" is adopted hereon.

The fundamental capacities and domain-general reasoning abilities of experts and non-experts are more or less identical, experts categorize and represent problems differently

(Chi, Feltovich, & Glaser, 1981). For example, Chi, Feltovich, & Glaser (1981) research findings (from a 1981 study of students learning tertiary level physics) suggest that novices (students) represent the more superficial surface elements in a problem whereas experts (teachers/tutors) categorize problems based on their deep structure, i.e. they reason using the underlying principles or elements of the problem. A related finding is that in addition to expert knowledge being deeper and more abstract, there are defining characteristics in the way novices and experts view problems (the problem schemata). This research demonstrates that the two key aspects of experts' knowledge - what experts know (declarative knowledge) and what experts can do (procedural knowledge) (as defined by Anderson, 1983) - are interrelated. Chi, Feltovich, & Glaser, 1981, explains the findings as follows:

Experts' schemata contain a great deal of *procedural knowledge*, with explicit conditions for applicability. Novices' schemata may be characterized as containing sufficiently elaborate declarative knowledge about the physical configurations of a potential problem, but lacking abstracted solution methods [my italics] (p. 151).

Basically, experts utilize their accumulated *procedural knowledge*, their methods or know-how, to determine which principles and methods to apply to solve a problem. Thus, in addition to an abstract understanding of the problem, experts can also invoke procedural methods to help deal with problems. (Chi, 2006, pp.22-23.). More contemporary studies conducted into vocational/professional skill sets support these findings. Feltovich, Prietula & Ericsson (2006), for example cites research that provides evidence of these interrelated dimensions in several work roles, including those of fire-fighters (Calderwood & Clinton-Cirocco, 1986), surgeons (Koschmann, LeBaron, Goodwin & Feltovich, 2001) and military pilots (Endsley, 1995). Subsequent expertise research has focused on the interrelatedness of deeper/abstract knowledge and know-how, identifying critical routine decision making skills.

Important characteristics of expert knowledge have been summarised below.

- Perceptual/cognitive skills in particular experts have ability to make fine discriminations, seem an essential component of expertise in many settings. They see more in a setting than a novice by noticing cues that a novice does not (e.g., Klein & Hoffman, 1992).
- Mental models – Experts have rich internal representations of how things work in their domain of practice (Rouse & Morris, 1986). These mental models allow them to learn and to understand situations more rapidly (Ross, Battaglia, Phillips, Domeshek, & Lussier, 2003). Mental models enable the decision maker to describe, explain, and predict (Rouse & Morris, 1986). They understand the dynamics of events in their domain. They know how tasks and subtasks are supposed to be performed, how equipment is supposed to function, and how teams are supposed to coordinate.
- Sense of typicality and associations – Experts have a large repertoire of patterns. They recognize what is typical in a situation (Ericsson & Simon, 1993) and they recognize complex patterns. They also recognize when things are not going as expected, that is, when there is an anomaly or something is missing.
- Routines – Experts know how to get things done (Anderson, 1983). They have a *wide repertoire of tactics*. They don't just know about things; they know how to do things.
- Declarative knowledge – Experts know more facts and details and have more tacit knowledge than novices do. They have command of more *explicit knowledge* [my italics], to use Polanyi's (1997) terminology, to go along with their *tacit knowledge*. Tacit knowledge is the operational knowledge inaccessible to consciousness. Much of expertise operates without conscious effort, and tacit knowledge supporting expertise is not verbally encoded, nor easily articulated (Crandall, Klein, Hoffman, 2006).
- Understanding one's own strengths and limitations (metacognition) – Experts are better self-monitors than novices (Chi, Feltovich, & Glaser, 1981).
- Finding leverage points – Experts can find leverage points in a situation and capitalize on them to implement innovative strategies (Klein & Wolf, 1998).

Leverage points are opportunities for making critical changes at relatively low effort.

- Managing uncertainty – Experts have a range of strategies for managing uncertainty in the field (Lipshitz & Strauss, 1997; Schmitt & Klein, 1996).

Thus, experts require a wide repertoire of tactics (actions) and a rich store of experiences (Anderson, 1983) which allow them to act quickly and decisively. These are automatic skills which are compiled over time and through repeated application and it is estimated that it can take up to 10 years to develop expertise (Ericsson, 1996). This body of research suggests that in specific work domains, the qualities of the organisation of knowledge around salient principles and robust procedures are prime characteristics of expertise (Billett, 1994, p.2). These procedures and principles are generally viewed as domain specific, i.e. being tied to the experiences, activities and decisions within a specific set of work practices and knowledge is conceived as relational - in that decisions contain both declarative and procedural knowledge.

However, a key problem is identifying these knowledge components which can vary widely across vocations, and depend on the work-specific demands and challenges. This raises the need to distinguish the nature of competency for specific workforces. In part, this has become the goal of later expertise research which has focused on mapping the expert requirements of specific workforces with a much greater focus on the situations in which decision making is undertaken. Research into decision making in *naturalistic settings* focuses on how experts make decisions, act and respond in actual work environments. A branch of these studies, *naturalistic decision making* (Klein, 2008; Lipshitz, 2001) has investigated processes of decision making, identifying a decision-making structure, the process of *recognition-primed strategy*. This provides important insights that are pertinent to the practitioners who work in complex work environments.

Studies investigating the decision making of fire-fighters (e.g. Klein, Calderwood, & Clinton-Cirocco, 2010; McLennan, Pavlou, Klein, & Omodei, 2005; Omodei, McLennan, & Reynolds, 2005) provide understanding about how experts make judgments and decisions and determine their repertoires of action (in this research known as courses of

action). As well as examining experts in relation to their naturalistic work settings, these studies seek to understand explicit processes of experts' thinking and acting.

Experts in these settings are typically required to 'size up' ongoing and dynamic situations, which includes having sophisticated situational awareness, ability to make on-the-hop and quick judgments and refined perceptual skills (Klein, et al, 2010; Klein, Calderwood & Clinton-Cirocco, 1986). Specifically, studies have found that experts typically use a *recognition-primed strategy* to make decisions in 80-90 percent of difficult decisions (Klein, 1999). Fundamentally, a *recognition-primed strategy* consists of two key processes; situation recognition and mental simulation. These are refined abilities to rapidly integrate information from a range of experience to 'size up' a situation and select a course of action through recognition and to assess interaction through mental simulation (Ross, Lussier, & Klein, 2005, p. 328). Experts run mental simulations to refine their course of action or to understand how a situation got to the point at which they found it (Klein & Crandall, 1995).

This is a process model of decision making; decisions occur across a sequence of activities and as such decisions are not one big decision act (i.e. make an assessment and then a decision). This was clearly illustrated in the original study (Klein et al, 1986), in which the fire-fighters interviewed believed that they rarely made decisions, as such - that they simply acted. Whilst the interviews demonstrated that these fire-fighters did make decisions, it is speculated that fire-fighters perceived decision making in this way as they did not directly compare multiple options. These studies concluded that expert fire-fighters do not have the luxury of time to compare several options and use recognition primed strategies more frequently than analytic skills. It is surmised that it is far more appropriate to use these strategies in incidents that require quick decisions rather than analytic decisions which require more time to consider.

Naturalistic Decision Making suggests that when assessing a situation experts spend time understanding the dynamics of the situation while novices spend more time deliberating over the course of action (Kobus, Proctor, Bank & Holste, 2000). However, it needs to be emphasised that these different categories of knowledge do not refer to generic capacities;

the cognitive structures were reported in terms being embedded in the context of application. Additionally, many facets of skilled work are tacit, and not immediately conscious to the skilled worker (Ericsson & Simon, 1984), which may account for the low frequency afforded to propositional knowledge.

Whilst this and other contemporary expertise studies provide more comprehensive accounts of complex thinking processes and stress the importance of strengthening links between the space where problems occur and how solutions are conceptualised, there are still concerns that these studies represent a weaker conception of context which underestimates the role social forces can play in knowledge formation (Billett, 1994). This concern ties into a second limitation. Whilst the above research raises the importance of practitioners gaining command of more explicit knowledge it also points to the inherently underspecified nature of some of the operational knowledge required of experts, characterized in the above descriptions of expert performances as automatic, tacit and unconscious knowledge. Hager (2000) notes that the notion of tacit knowledge is ambiguous, masking a range of capacities important to workplace actions, especially non-routine actions required in complex workplaces, and proposes that understanding more about these *practical judgements* in workplace learning is critical. He further argues that tacit knowledge can, and should, be made explicit for learners and outlines various dimensions of these types of judgements in order to progress understandings of this type of learning.

Problem-solving in this view is conceived as the principle activity associated with learning (Anderson, 1993; Shuell, 1990) and transfer, which is “dependent upon access to previous knowledge and the use of higher order or strategic procedures to manage and monitor these activities” (Gott, 1989, cited by Billett, 1994, p.2). This body of research suggests that explicitly identifying important aspects of expertise, as well as including a focus on the nature of the problem-solving required in activity, provides opportunities to frame instructional improvements.

2.4 Conclusion

The literature reviewed above has revealed that the nature of workplace learning is a complex amalgam of cognitive, social and physical factors. Constructivist learning perspectives are important to this thesis because they reveal the value of knowledge acquired by cognitive understanding of underlying principles, which allows for generalization and transferred application to new situations. From this perspective learning is a process of knowledge construction, as opposed to knowledge recording or absorption, in which higher level thinking and problem-solving is built upon mastery of underlying principles. Considerable emphasis is given to the interplay between what is taught and the way it is taught, pointing to the value of teaching for understanding and the importance of problem-solving activities in this process. However, these theories are also limited because they overlook the social factors which impinge upon the learning process.

Situated learning perspectives are also useful to this thesis because they illuminate a range of other factors which impinge upon workplace learning – social, cultural and physical - prompting the assertion that participation in the workplace community of practice is the central component of workplace learning. The effectiveness of the learning is determined by the degree to which the novice is enabled to participate meaningfully in the community of practice, initially at a peripheral level but followed by tasks of increasing complexity and responsibility. Studies of workplace learning in fire and emergency services attest to the importance of mentorship in this process toward full participation and expertise. However, while these theories are useful they too provide an incomplete picture in that they tend to minimise the importance of the cognitive aspects of learning.

Studies of expertise have helped to delineate the characteristics of expert action and decision making. While there is complexity involved and some areas seem ambiguous (the nature and function of tacit knowledge, for example) it can be surmised that expertise is built upon a foundation of theoretical understandings amalgamated with mental simulations and schema formed during wide-ranging work experiences over time. In this sense, expertise is a marriage of cognitive understanding with practical experience. It follows that cognitive constructivist and situated learning theory, as well as studies of

expertise, have important contributions to make in the design of the workplace learning curriculum and to provide understanding of key points for analysis of a workplace training course. These elements will be discussed, where applicable, in the findings of this thesis.

Chapter 3

Method

The previous chapter outlined the literature relating to the theoretical development that has already occurred, pertinent to this thesis. This chapter discusses the research focus and provides some background to the research project (section 1). A synopsis of the case design is then provided (section 2), which includes the outline of criteria by which the design enquiry may be judged and a description of the phases of research (section 3) and the processes of data collection (section 4). Section 5 details the processes of data analysis. The chapter ends with a summary of the verification procedures used to maximise validity of the research findings (section 6) and a synopsis of the limitations of the study (section 7).

3.1 Emergence of a research focus and rationale for case selection

This study's focus initially emerged from expressions of concern about the limited research into the training and education of bush fire-fighters and in particular how bush fire-fighters develop expertise in relation to the science of *bushfire behaviour*. A review of the literature undertaken earlier identified several broad challenges facing this industry and the increasing pressure these circumstances place on building bush fire-fighter expertise (as outlined in chapter 1). Similar concerns have been raised in major inquiries over the previous decade, articulating a demand to ensure that basic training is available to all bush fire-fighters, nationally accredited and delivered within the Public Safety Training Package. Despite the large numbers of people involved in bush fire-fighting in Australia, an estimated 220,000 volunteers (McLennan & Birch, 2005) and over 30,000 career bush fire-fighters (AFAC, 2013), there has been limited research into the basic training of bush fire-fighters (Hayes et al, 2004). Additionally, research into the efficacy of competency-based training and teaching approaches delivered via training packages has demonstrated ongoing issues surrounding the competency model (see for example, Gonczi & Hager, 2010).

Following from a further review of the literature and in order to develop the study beyond this initial survey, an *embedded, single case study approach* (Yin, 2009; Creswell, 2002; Merriam, 1998; Stake, 1995) was adopted. Creswell defines a “case study [as] a problem to be studied, which will reveal an in-depth understanding of a ‘case’ or bounded system which involves understanding an event, activity, process, or one or more individuals” (Creswell, 2002, p. 61). It identifies the incorporation of sub-units of analysis in a single case study, an *embedded analysis*, providing scope for a more complex and embedded design to be developed, one which provides significant opportunities for extensive analysis as well as enhancing insights into the single case. This embedded design was adopted in my study. In this instance, the initial focus on a *single* organisation’s training program provided a contextual overview of training factors. To investigate these in depth (i.e. to examine the sub-units nested within the overall case study) it was decided to observe the conduct of training by a single bush fire-fighting agency.

This prompted a decision to undertake an initial broad-based investigation of how basic training for bush fire-fighters is being conducted, which aligns with the key focus of this study - to gain insight into how individuals learn, and specifically how entry-level bush fire-fighters learn about bushfire behaviour knowledge and skills. A focus on novice learning and basic training presents a suitable case for examining the factors which influence how individuals learn and how this learning may affect subsequent development. Novice learning, and particularly entry-level training, constitutes the principal tool for bush fire-fighter induction and initial accreditation - the foundational element whose effectiveness should be crucial to the individual’s subsequent development as a bush fire-fighter. It follows that novice learning in this context presents a suitable case for examining individual learning, its influences and potential for the development of skill.

A close examination of how curriculum and learning experiences are organised around this foundational knowledge, within the context of a contemporary training setting, can provide rich information about the demands and practicalities of training and how this influences curriculum delivery and what is taught and learned. This examination may also

yield information about how participants' roles are defined, their intentions, perspectives and motivations and observation of activity in these contexts can provide information about how learning is shaped, conceived and enacted.

Thus, case selection was purposive in order to guarantee richness of information (Flyvbjerg, 2004). The need for a detailed examination of these factors required access to a typical training program conducted by one of the bush fire-fighting agencies in Victoria, willing to engage in the process. This was facilitated by the Department of Environment, Land, Water and Planning which is a Victorian State Government land management service.

The following section provides a synopsis of the case design alongside some key problems associated with adopting an inquiry of this type.

3.2 The research design

My commitment is to study the complexity involved in a real situation, which aligns with Simons' (2009) definition of the case study as an "in-depth exploration from multiple perspectives of the complexity and uniqueness of a particular project, policy, institution, program or system in a "real-life" context" (p. 21). The design assumes that sensemaking and meaning perspectives are deeply embedded in the social fabric of learning contexts and communities of practices (Lave and Wenger, 1991), and aims to investigate multiple perspectives in context. The multiple perspectives are layered from within the '*bounded context*', starting from the broader context of the case, (i.e. the training context of entry-level bush fire-fighters) and its curriculum goals, subsequently examining trainee and trainer perspectives from within their learning contexts and finally focusing on two contrasting examples of enactments of learning.

Whilst the study focuses on a single case, these embedded and multiple units of analysis reflect several rationales within this context. Yin (2009) argues that a *single* case design is eminently justifiable under certain conditions and he outlines five rationales that are relevant. Two are particularly pertinent to my study – that a case may be *representative or typical* and that it may serve a *revelatory* purpose (Yin, 2009, p.48).

As previously described, the earlier investigation considered the broad training context with the goal of capturing the everyday experience of training. As the training context is part of a national and standardised curriculum for bush fire-fighters, the case study might be said to be indicative of what might typically occur in the training of entry-level bush fire-fighters in Australia, shedding some light on the national training and curriculum agenda. This may be further enhanced by investigating more deeply the attitudes of trainees and trainers from within the context of a real training setting. The single-case study provides the opportunity to dig deeply, allowing an observer to gain access to a phenomenon that was previously inaccessible and thus furnish a revelatory function. By providing these deeper and richer accounts it is hoped that the lessons learned may be informative of the experiences of the average person (Yin, 2009, p.48). However, the detailed nature of this type of examination of what is essentially a single case may limit the extent to which its findings are generalizable and transferable.

In response to the methodological challenges of such case design, Merriam (2002) argues for an enhancement of case design within the frame of *qualitative, interpretative* research alongside *naturalistic inquiry* goals. An *interpretive, qualitative* research design uses multiple sources of data collection and has four key characteristics (Merriam, 2002, p.6):

- The researcher is interested in understanding how participants make meaning of a situation and a phenomenon;
- This meaning is mediated through the *researcher as instrument*;
- The strategy is *inductive*; and
- The outcome is descriptive, providing a rich description of the context, enabling theoretical constructs to be developed.

First, the *interpretive qualitative* design is particularly appropriate for gaining deeper *understanding* of the meaning that people construct of their world and their experiences (Merriam, 2002, p.4). In addition to these *naturalistic inquiry* goals of seeking to understand more about how people make sense of their experience (Merriam, 2002), an interpretive design can lead to both instrumental and theoretical goals, by garnering information about areas in which little research has been done (Merriam, 1998) and

furthering understanding of issues or concepts which have not been deeply investigated so far (Yin, 2009). Defining a study as *interpretive* indicates that data have been collected and coded not only to describe but also to support, challenge, or develop theory (Merriam, 1998).

Secondly, as *understanding* is the goal of interpretive research, having the researcher as a primary research instrument is appropriate because it provides scope for adaptive, responsive and sometimes immediate approaches to data collection and analysis. This is an advantage because the researcher, for example, can clarify and summarize material, check with the respondents for accuracy of interpretation and explore un-anticipated responses (Merriam, 2002, p. 5).

Thirdly, the data is collected via a range of approaches (in this study the sources include interviews, observations, document analysis and surveys) and subsequently “*inductively* analysed to identify the recurring themes or common patterns that cut across the data” (Merriam, 2002, p. 6-7). Key to the *inductive, naturalistic* approach is to understand the meaning of a phenomenon or situation from the viewpoint of those involved and then to work inductively across the data to concepts and theory that help to explain the phenomena, the processes and/or perspective of the participants involved. This culminates in the fourth and final characteristic of an *interpretive design*; which is to provide a rich descriptive account of the findings, referenced to the literature that frames the study.

In adopting an *interpretive, qualitative* research design to better frame my case study, it was necessary to anticipate and act upon some of the potential weaknesses of this approach. For example, this approach opens the possibility that the researcher’s own biases and subjectivities might unduly influence the path of the inquiry (Merriam, 2002) and thus outcomes. Similar concerns about the potential influence of the researcher’s biases on participants’ responses is raised elsewhere (e.g. Creswell, 2012).

Merriam argues that this is a consequence of most qualitative research, and as such it is important to identify and monitor “subjectivities” and how they might be shaping the collection and interpretation of data. To these ends, it is crucial to ensure the collection of

data is carried out accurately because interpretations and judgements are based upon it (Merriam 1998). The methods used to maintain accuracy in my study will be outlined in section 3.4 below, which explains the key methods adopted and in 3.5.1 which describes how the data was prepared and organised.

3.3 Phases of the research

This study has been conducted over four phases and Table 2 below outlines the tasks I undertook during each of these. It outlines the specific tasks I undertook and the timeframe for the phases. Phases three and four were undertaken on a part-time basis. A more detailed outline of the four phases is provided following the table.

Table 2: The three phases of the research and key activities

PHASES	ACTIVITY	TIMELINE
Phase 1	Reviewing literature and writing draft; Familiarisation in the field of ‘bushfire behaviour’ training and the range of learning tools available for use in training; Undertaking the process of seeking research participants; and Gaining ethics approval for the study; Data collection at General Bush fire-fighter training camps.	2007 (mid) – 2008
Phase 2	Immersion and investigation into curriculum and training practices; Preliminary data analysis and reporting back to agencies; Additional data collection included conducting surveys and more interviews; Drafting chapters; and a Further review of the literature.	Mid 2008 - 2010
Phases 3 & 4	In-depth data analysis; Follow-up interviews and workshops to triangulate findings with industry trainers; and Thesis write up. (Several major breaks occurred during this period owing to personal health problems).	2011- 2015 (May)

3.3.1 Phase 1

As identified in chapter 1, the broad challenges facing this industry mean that there is greater pressure to build bush fire-fighter expertise. In the light of these concerns, I started my research by conducting an initial review of literature to provide insight into bush fire-fighting training and learning contexts in Australia. This identified some general concerns about how the content of *bushfire behaviour* was being taught to bush fire-fighters.

To familiarise myself with this field, I undertook four main activities. First, I was invited to attend (as an observer) a four-day workshop on developing understanding about *bushfire behaviour* in the context of organising and managing prescribed burns. This workshop was led by Jim Gould, an international expert in the field, and other members of the CSIRO's⁹ Bushfire Dynamics and Applications Group and was attended by forestry managers with the NSW Forestry Corporation.¹⁰ I also participated in a workshop that examined implications of the latest *bushfire behaviour* science findings on the bushfire response (Hobart, September, 2007).

Secondly, because one emerging approach to teaching bush fire-fighters about *bushfire behaviour* involves the use of computer software designed to replicate the effects of fuel, weather and topography on bushfire, I familiarised myself with several these programs and examined some research literature regarding the use of these type of computer models in bush fire-fighter training.

I presented a summary of these early reviews and the aims of my research at the industry's primary annual conference – the *AFAC conference* (Hobart, September, 2007) and again at the *AFAC Learning and Development Group* meeting (Melbourne, May, 2008). The object of these presentations was to gauge the level of interest in this type of research at these two industry levels¹¹ and to establish contact with individual agencies who might be

⁹ The CSIRO, the Commonwealth Scientific and Industrial Research Organisation, is Australia's national science agency.

¹⁰ Forestry managers from across the Australian state of New South Wales attended the workshop. This workshop's specific aim was to work with bushfire managers to help them to examine the implications of new research outcomes in bushfire behaviour for their own bush fire-fighter practices, particularly in relation to their prescribed burn operations.

¹¹ *The AFAC conference* is organized by the Australasian Fire and Emergency Service Authorities Council (AFAC) and in conjunction with the Bushfire Cooperative Research Centre (BCRC). AFAC membership is open to members who

interested in participating in the research. As the initial survey of the literature appeared to indicate rather limited pedagogical approaches to training in ‘bushfire behaviour’, I was particularly interested in working with agencies who were exploring the possibility of new approaches or already in the process of changing their teaching and learning practices. At the latter meeting personnel from the agency which became the host of my study identified an interest in participating, as they were introducing a new approach to parts of the training in their entry-level bush fire-fighter course.

Approval for the study was granted by the University of Tasmania Human Research Ethics Committee. The details of how participants were recruited is provided in section 3.4.2 below. Participants were provided with an information sheet and a consent form and an example of these forms are provided in full in Appendix B. The details of the requirements and risks associated with the study are reported in this document.

3.3.2 Phase 2

This phase comprised the data collected which was undertaken over a two and half year period. In brief, this phase started with a familiarisation with the participating agencies curriculum and then data was collected across three separate training camps. Once the preliminary findings of this first data set was completed, additional fieldwork was undertaken. This culminated in an analysis of this data and the drafting of the findings chapters.

I was also invited to observe and conduct interviews at a three-day curriculum review workshop, attended by the key training managers and trainers from every region in Victoria. This allowed me to start to build relationships with trainers, to immerse myself in the curriculum and the contents of the training package and to better understand trainers’ intentions and their challenges. I also collected relevant curriculum documents.

work as part of organisations that have responsibility for delivering or supporting the provision of fire, land management, community safety and emergency services. The annual AFAC conference is attended by these members from across Australia and New Zealand.

The Learning and Development Group is organised by AFAC and is represented by educational and training leaders from member organisations across Australia. The Learning and Development Group aims are to provide “leadership in best practice in learning and development through innovation, collaboration and an ongoing commitment to professional development” (AFAC, 2013).

Interviews conducted at this stage enabled me to start to build insights into the trainers' main concerns and challenges with regards organising and delivering the training.

Subsequent meetings with training management personnel involved follow-up discussions about the curriculum review and I also sought additional curriculum documents. Decisions about the General Bush fire-fighter training camps to be observed were negotiated at this time. It was a complex task to coordinate the sites that I would be able to attend as the training occurs in a short period of time across multiple sites for multiple cohorts. The training is also only offered at specific periods of the year. The lengthening of the bushfire season means that operations can start whilst the training is still underway, resulting in some shifts in their training schedules alongside other logistical consequences (particularly whether they could free up enough assessors for the camps). This limited to some extent the range of camps to select from.

Two sites were selected as these were camps set in two contrasting locations. One was a rural setting but close to larger populations and the other was in a more remote part of Victoria which is more sparsely populated but where bush fire-fighting occurs in larger forested areas and there is more mountainous terrain. From the available sites remaining, a further camp was selected as this was where a new approach to teaching the *bushfire behaviour* unit was being trialled.

Data was gathered at these three separate entry-level bush fire-fighter training courses and interviews and observations were the key approaches used in this investigation. The training course, the *General bush fire-fighter* course, runs over 4 to 5 days and is usually conducted at live-in camps. These training camps are run by the Department of Environment, Land, Water and Planning which is a Victorian State Government organisation and are based at its regional centres. The camps I observed were conducted at three different centres and attended in all by 80 trainees and 10 key trainers. I attended the total 15 days available.

A key focus of this stage was to develop familiarity with the participants' culture and to build relationships and trust with participants, which was achieved via the intensive

fieldwork. Trainers' and trainees' perceptions of the training was of key interest. Once analysis of interviews and observation data was processed, a preliminary report was prepared for the participating agency outlining some early findings. Training managers were consulted about the report and follow-up interviews with trainers were undertaken. I also talked with training managers at the end of the fire season (which occurred after this first fieldwork), to gauge how they thought novices progressed in their first work placements and what bush fire-fighting activity novices were involved in. These early results provided the catalyst for a second review of the literature focused on the nature of expertise and situated learning theory. An early draft of chapter 4 was also prepared at this stage.

To supplement gaps in this first data set and to extend understandings, additional fieldwork was undertaken. This work was at three additional bush fire-fighter training sites, at a train-the-trainer's workshop and through participation in end-of-training reviews over several training seasons. This culminated in an analysis these two data sets as follows.

3.3.3 Phases 3 & 4

The analysis focused on an exploration of trainers' and trainees' perspectives (see chapter 5 & 6) followed by an analysis of video observations of two distinct ways of conducting training specific to the understanding of the theoretical components of the curriculum pertaining to *bushfire behaviour* (see chapter 7 & 8). Informed by this and detecting what seemed to be a shift in trainer thinking, a third examination was undertaken. The final writing and editing of the thesis was then completed.

3.4 Methodology

This section explains the method and tool employed to collect the data for this thesis.

3.4.1 Processes of data collection

Various methods were used to collect data; interviews were audio-taped, relevant lessons were video-taped and full, verbatim transcripts were prepared by the researcher. In order

to maximise reliability, a case study protocol and synopsis of the case database was developed. This protocol/synopsis was revised throughout the process and the final version contains the research questions, sites visited, the data collection plan and the data categories and codes. These strategies accord with the quality criteria suggested below (section 6), to enhance the validity and reliability of the research process.

3.4.2 Recruitment of interview participants

The participant recruitment occurred at the three training camps and the participants were selected for interview in several ways. After being introduced on the first morning of the camps, I provided a brief outline of my study and let participants know I would be seeking to interview trainees as the week progressed. First, as I was living-in at the camps and followed trainees through their training, I enabled me to talk with most trainees and all trainers informally. There was ample time to get to know the trainees in and out of the classrooms and I found that many of them were keen to talk with me about the training. Trainers also talked with me openly and frankly as the course progressed, pointing out difficulties they were experiencing and giving me a sense of how they thought students were progressing. All my study participants were selected to provide multiple perspectives (Creswell, 1998). I did this by ensuring that I had a mix of experience and age levels, as well as targeting those who seemed to be enjoying the training and those who were less enthusiastic.

Multiple interviews were undertaken and a theme identified only after it recurred in several interviews. In addition, repeat interviews with participants were undertaken. A full description of how the data collection was managed to ensure veracity is outlined 3.6.

3.4.3 Trainee participant selection process

Trainees were initially selected for interviews on an opportunistic basis. This was determined purely by their availability (usually during breaks or after tea at night) and as the program was intensive and there was very little ‘down-time’, this meant taking opportunities as and when they arose with students that were available at these times. As the week progressed, I was keen to get a good range of views and opinions and, having

gained a sense of trainees' backgrounds and their reactions to the training, I narrowed my selection to those who might provide other perspectives. Towards the end of the week, I especially singled out trainees who struggled with the course or who openly expressed concerns about the training, in part because I had already collected a lot of data that mainly reflected what a positive experience had entailed. Although the trainers did not generally help me select the trainees to be interviewed, they expressed a keenness to understand how training is perceived from a range of perspectives and helped me by encouraging trainees to participate in the interviews.

3.4.4 Trainer participant selection process

Trainers were selected for interviews based on how central they were to the organization and delivery of the coursework. Each camp consisted of key trainer/camp managers as well as local crews who came to assist at practical sessions with equipment, (e.g. fire trucks, slip-ons, communications equipment) as well as local qualified crew members who assisted as assessors. Although I talked with some of these extra personnel, their time at the camp was restricted and there were few opportunities to interview them. As I was keen to get more in-depth interviews with the key trainers and because of the intense and hectic training schedule, I conducted interviews with many of them in periods following each camp. Some of the interviews were repeat interviews conducted over a six-month period as I continued to develop an understanding of the issues.

3.4.5 Interviews

Semi-structured interviews were conducted between the researcher and individual trainers (n= 12) and trainees (n= 22). The interviews were conducted face-to-face or over the telephone (or via the use of Skype). Trainee interviews averaged 20 minutes and trainer interviews averaged 45–60 minutes in duration. Most interviews were audio recorded. Table 3, below, provides a summary of the number of trainer/trainees interviewed across the three training camps.

Semi-structured interview technique incorporates prepared interview questions that serve as a 'guide' to the interviewer but allowing scope to ask more open-ended or probing

questions (Roulston, 2010, p.16). For the interviews conducted at the training camps, interviews were structured to elicit the participants' in-depth experiences of the training. For both trainees and trainers, specific prepared questions focused on gaining background information, including professional/schooling background, motivation for becoming a bush fire-fighter /trainer and trainees' prior knowledge and level of experience in this workplace.

Table 3: The number of trainers/trainees interviewed across training camps

CAMP	NUMBER OF TRAINER INTERVIEWS	NUMBER OF TRAINEE INTERVIEWS
Camp 1	4	10
Camp 2	4	9
Camp 3	4	3
Total	12	22

Note: Camp 3 was a regional camp and as trainees did not stay overnight there were fewer opportunities to interview them.

For trainees, the more open-ended questions focused on how they were progressing in the course, what aspects of the course they were finding challenging and what they were feeling confident about.

For trainers, the questions ranged from general to very specific questions. They were asked to recount specific teaching sessions, why they have chosen to teach in this way, and how they teach the 'bushfire behaviour' content. More general questions related to general reflections on how they believe understanding develops, what contributes to trainee learning and building bush fire-fighter capabilities. The questions were designed to gain understating about aspects of the trainers' pedagogical content knowledge (Shulman, 1987). The set of interview questions that guided these interviews is found in Appendix A.

During the camps, I talked with each trainer about my study and handed each one an information sheet to read (see Appendix B for a sample copy of this form). All trainers

were happy to have the interviews recorded except for one. This trainer did not want to be recorded as he/she held some strong negative views about the effectiveness of the training and felt more secure in expressing these without being taped. For this interview, I took notes and to ensure accuracy stopped the discussion from time to time in order to provide the trainer with a short summary of what I understood he/she was saying. This allowed the participant to feel freer to voice more critical opinions. I used the strategy of paraphrasing for some of the recorded interviews as well, especially for instances where the trainer may have been expressing more guarded views or aspects that weren't consistent with views more generally accepted. This ensured that my interpretations were correct and allowed me to probe further where needed. There were many instances where I asked trainers to further clarify their technical jargon to build my own understanding and to ensure that the contextual information was being accurately portrayed.

As I was based in Hobart¹² and the trainers in various locations across the state of Victoria, interviews subsequent to the training sessions were conducted via telephone (or using Skype). During these, I reminded the trainers of my desire to record, obtained their permission to do so and advised when I was turning the audio recording on and off. Where possible I used Skype to call the participants and used a simple plug-in that allowed me to record the conversation (audio only) and save the files to a MP3 audio file. These tools provided better recording quality than attempts to record telephone calls.

As *General bush fire-fighter* training camps generally operate in a cluster around the months prior to the coming bushfire season (usually October to December), trainers were involved in conducting several camps which gave me an opportunity to ask how typical the observed camp was and to identify any points of difference with other camps they had already conducted.

A conscious effort was maintained during interviews to avoid leading the interviewee toward any preconceived expectation of the researcher. Questions were framed in an open manner and care was taken not to “endorse” any particular response. When statements

¹² Hobart is the capital of Tasmania, an island state of Australia and is a one-hour flight from Victoria.

appeared ambiguous the researcher sought clarification by paraphrasing them and seeking confirmation of the intended meaning. Multiple interviews were undertaken and a theme only identified when it arose from several interviews.

3.4.5.1 Follow-up interviews and journal maintenance

Keeping a journal of particular events and aspects of the training course, or opinions expressed by individual trainers which needed further clarification, enabled me to discuss them with the trainers in more depth during the subsequent interviews. For example, on the last day of one of the camps during an assessment session, one trainer expressed concern about the approaches used in the oral exam and talked to me briefly about a tactic they use to improve the experience for the learner. During the subsequent interview, I encouraged the trainer to elaborate on this subject. These follow-up strategies provided opportunities to develop consistency across my data sources. They enabled me, for example, to check for typicality of how the camps were conducted across a region and then across other regions. They also enabled comparison of the perspectives of people with different points of view, referencing concerns raised by trainees against those of trainers and cross-checking whether these concerns were indicative across regions.

Keeping a journal of my own learning during the camps and subsequent data collection enabled me to build a picture of the themes arising from the data and subsequently seek feedback from trainers regarding some of the formative interpretations or theories which arose. It also enabled me to refine my data collection plan. Merriam (2002) makes the point that data analysis and data collection should occur simultaneously; “it allows the researcher to make adjustments on the way, even to the point of redirecting data collection, and to ‘test’ emerging concepts, themes, and categories against subsequent data” (p. 14). For example, I found that by the time of my third camp I was far more conversant with the curriculum goals and trainers’ pedagogies. This enabled me to dig more deeply into their attitudes and values around learning, what they think makes a good bush fire-fighter and their understandings about how expertise develops.

Participating in the intensive nature of the fieldwork, following trainees through their entire training process, proved to be the most valuable aspect of the data collection. Not only did it allow me to gather an extensive amount of data but also to become immersed in the social setting and able to build relationships. This commitment to understanding their experience meant that in general my presence was appreciated; my questions were given respect and many happily gave of their time. For example, trainers at all three camps included me in their daily ‘training’ debriefs, often treating me as a sounding board with one camp inviting me to observe and contribute at their end-of-camp review process.

3.4.6 Observations

Real-time observations were conducted of several units conducted in the training camps and I used a prepared protocol to organise my notes on these observations (see Appendix C for the Observation check sheet). Additionally, I undertook observations and collected video data of two contrasting teaching approaches used in the entry-level bush fire-fighter course to teach the core theoretical unit, the *Basic Bushfire Behaviour* unit. The session video-recorded in ‘Observation 1’ was delivered in the form of a lecture conducted from the front of a classroom with *PowerPoint* slides and the whiteboard to illustrate his points. This was the traditional way this theoretical unit was delivered and the session was indicative of the standard approach used. ‘Observation 2’ used a simulation-based approach to deliver the same theoretical concepts using the *bushfire simulation table*. The video data was recorded on one camera and the researcher also took notes as the lessons proceeded. Triangulation of observations with the comments made in interviews enhanced the consistency of the data collection process.

3.4.7 Evaluation of coursework documents and materials

The documents and curriculum materials collected ranged from written, visual (e.g. photographs, graphics, multimedia software) and cultural artefacts (e.g. policy documents, mission statements). Merriam (2002) notes that “the strength of the documents as a data collection source lies with the fact that they already exist in the situation; they do not intrude upon or alter the setting in ways that the presence of the investigator might” (p.

13). For this study, the key artefacts that were collected for analysis included the *Basic Bushfire Behaviour* curriculum unit, associated curriculum and assessment documents and video recordings of the two contrasting approaches to teaching this unit. This collection of artefacts provided the scope to analyse the implementation of the curriculum unit as well as to triangulate the data.

A range of curriculum documents was collected including the training package used in all training camps, which comprises of a set of *PowerPoint slides* and teacher's notes, including the key objectives of each unit and a range of DVDs. Other significant curriculum materials I had access to include the *Student Learning Manual*, a web-based preparation course and all assessment materials. The teaching objectives and the assessment material were both carefully reviewed and a result of this analysis is available in chapter 4 and chapter 7. Other related documents included for review comprised the participating organisation's internal training policy documents, including their internal annual reviews and two Royal Commission submissions containing details about their training and early mentoring processes. Additionally, a range of Victorian Government documents, Commonwealth documents and other demographic and statistical analysis helped to build my understanding of the context of training in the state of Victoria.

3.4.8 Further activities and interviews with expert trainers

In accordance with case study methodology, I purposefully sampled participants who had presented workshops directly related to my study - providing intentional, sustained spaces for exchanges to occur in relation to classroom contexts (Creswell, 1998; Merriam, 1988, 1998).

3.5 Data analysis

Van Maanen (1979) defines a key analytic task of research as seeking to "uncover and explicate the ways in which people in particular (work) settings come to understand, account for, take action and otherwise manage their day-to-day situation" (p. 540). Therefore, conveying an understanding of the cases is the overriding, essential consideration in analyzing the data (Merriam, 1998). To achieve similar broad aims, my

data analysis primarily took the form of an inductive method in order to ‘uncover and explicate’ as well as interpret the experiences and thinking of novices and trainers. Three steps were undertaken;

1. Preparing and organising the data;
2. Reading, sorting and coding the data and
3. A detailed analysis stage

Table 4 below sets out these three stages. Miles and Huberman (1994, p.332) identify a classic set of analytic processes and these were all used in my own analytic approach. These key analytic processes are set out in the second column in Table 4 (on the following page) with the third column being a summary of some specific processes I undertook and which are further detailed below the table.

3.5.1 Step 1: Preparing and organising the data

The interview and video data was transcribed and any script which identified people, places, etc. was removed. Codes were affixed to this data as well as the observation notes and other data collected. As the data comprised a range of sources; these sources were given categories, e.g. “1” = trainer interviews, “2” = novice/trainee interviews, etc.

Transcribed audio interviews were allocated a number code for each interviewee, allowing the identity of individual participants to be removed. To distinguish trainer and novice/trainee interviews, the letter “T” was assigned to interviews undertaken with trainers and the letter “N” to those of novice/trainees. For example, for the first level of data collection, T1-T12 represents the trainers interviewed and N13-N34 are the codes allocated to the novice/trainee interviews. This accords with strategies aiming to enhance the validity and reliability of the research methods used.

Table 4: A summary of steps used in data analysis

	HUBERMAN AND MILES' SIX ANALYTIC PROCESSES	PROCESSES SPECIFIC TO THIS STUDY
Step 1- preparing and organising the data.	Affixing codes to a set of field notes drawn from data collection.	Transcripts were de-identified; Codes were affixed and categories were formed.
Step 2 - reading, sorting and coding the data	Noting reflections or other remarks in margin; Sorting or sifting through the materials to identify similar phrases relationships between themes, distinct differences between subgroups and common sequences.	The data was first sorted using a qualitative software program, called NVIVO; The data was coded using a proven set of codes; A report of the initial analysis was prepared and reported back to the participants.
Step 3 - detailed analysis stage	Isolating patterns and processes, commonalties and differences; Gradually elaborating a small set of generalisations that cover the consistencies discerned in the data base; Confronting those generalisations with a formalised body of knowledge in the form of constructs or theories	'Meaning units' were identified; A list of common features emerged and these were compared across the data; New categories and sub-categories were formed.

3.5.2 Step 2: Coding, viewing and sorting the data

To retrieve this data easily and preserve its context, data codes were assigned, as described above, and sorted using a qualitative software program, called *NVIVO*. For the

first investigation of the data collected at the three training camps, a set of pre-specified themes was used to further code the data in order to organize in a more structured form and bring more clarity to the information to be sorted. The themes used were a set developed from a previous study I had undertaken which examined trainers' and novice learners' perspectives of online learning (see Salter & Bound, 2009). The initial themes were modified to some extent as additional themes began to emerge through the reading phase and some themes were discarded when no responses seemed to correspond. Table 5 on the following page outlines these themes.

The software enabled me to store, index and search across these key themes. To achieve this, I imported each digital interview transcript into the software, read through each transcript and (whilst in the database) directly selected text to assign to the themes. I organised pertinent journal and observation notes in a similar fashion, and by using the same set of themes, enabled me to link these thematically to my interview data. A broad-based perspective of the training was produced from this initial analysis and organised in the form of a report for the training organisation involved in the study.

3.5.3 Step 3: Detailed analysis stage

In line with the interpretive and revelatory purposes of the thesis, a different and more inductive method was used for the investigations (undertaken in Phase 3 as illustrated above). The interview data was sorted to identify similar phrases, to examine relationships between themes, to identify distinct differences between subgroups and to identify common sequences (Miles & Huberman, 1994; Tesch, 1990). In the first instance, the analysis of the interview transcripts was undertaken from a mainly experiential point of view, allowing me to capture the lived experiences of participants in training and the meanings that trainers and trainees bring to those experiences (Lave, 1991). To uncover patterns in the data I used the two-step process of de-contextualization and re-contextualization as proposed by Tesch (1990).

Table 5: The themes used to process the initial data set

KEY THEMES	SUB-THEMES
Trainee/trainer background	Current work or studies, previous work or studies, bush fire-fighting experience, age
Knowledge	Prior knowledge New knowledge <i>PowerPoint</i> presentations
Resource and tools	Video Other (manuals, worksheets etc.) Evaluative comments and suggested improvements
Assessment	Oral/written Practical/Techniques Evaluation
Learning	Experiential learning Motivation/confidence Practical Environment (classrooms, camp set up, ambience etc.) Cognitive processes (discusses thinking processes) Metacognitive (reflects on their own thinking process)
Teaching	Teaching approaches (e.g. chalk and talk, team teaching) Teaching presentation, quality of delivery Teaching effectiveness/appraisal.
Bushfire simulator (BFS)	Prior knowledge Key content points Teaching approach Appraisal
Other	Motivations to take course Preparation for course Projections to bush fire-fighter work

First, I read the transcripts one at a time, initially identifying ‘meaning units’, which are words, sentences or entire paragraphs that appeared to capture key thoughts or concepts as well as “a segment of text that is comprehensible by itself” (Tesch, 1990, p.116). This first step is important in the data analysis stage as data segmenting can lead to loss of contextual relevance (Tesch, 1990). I coded each of these units with a key descriptor that reflected the idea on the left margin and noted my own reflections or other remarks in the other margin (Miles & Huberman, 1994). A list of common features emerged from the ‘meaning units’ identified, these were compared across interviews and then organised into new categories. This process was conducted using hard copies of the interview transcripts; by physically cutting each segment of data and removing it from its original contextualised place (de-contextualizing) and placing it alongside common ‘units’ to form new categories (re-contextualization). This process allowed me to start the more detailed analysis.

The video digital files were directly imported into my NVIVO database file as well as the transcript. I time-stamped the videos as they played and attached the corresponding piece of transcript to the video. This enabled analysis of the pedagogies in use – for example Bloom’s taxonomy (1956) to indicate different levels of thinking was used to classify the types of questions used by each trainer. The detailed analysis started with forming the new categories. Recurring themes were re-ordered and re-contextualized, and by examining the new organising categories, I could isolate patterns and gain a sense of the whole. For the trainer and trainee interviews this allowed me to explicate aspects of their perspectives as well as to uncover emerging themes (see Table 6 below). For example, contrasting pedagogical perspectives became apparent in trainer interviews (see chapter 6) and by collating the extracts that pertained to specific pedagogical aspects enabled me to identify sub-themes in these contrasting perspectives. These emerging themes were further enhanced and developed through my participation in industry conferences as outlined in Table 7. This illustrates consistent engagement in the industry.

Table 6: Example of coding

MAJOR CODING CATEGORIES	SUB-CATEGORIES
Demographics	Role/position
	Experience as bush fire-fighter /trainer
	Educational background
Perceptions of knowledge requirements as trainers	Importance of bush fire-fighter experience
	Currency of knowledge about bush fire-fighter practice, policy, safety equipment etc.,
	Knowledge of their organisation/the communities they serve
Perceptions about bushfire behaviour knowledge	Knowledge builds with experience
	Knowledge builds alongside the skill
	Knowledge proceeds the skill
	Knowledge is easy to learn and the classroom provides building blocks
	The criticality of this skill for all bush fire-fighters
	The importance of mastery of the skill in order
	The role of mentoring in early skill building

Table 7: Industry conferences and other publications

TYPE	AUTHOR, YEAR, TITLE	CONFERENCE, PLACE
Conference presentation	Salter, A. (2012), Education strategies in fire behaviour training: the case of the bushfire behaviour table.	BCRC Research Activity Forum, Hobart, Australia.
	Salter, A., & Harry, G. (2010), Using the 'bushfire simulation table' – teaching and learning effectiveness.	National Emergency Services Training Officers Conference (NESTOC), Brisbane, Australia.
	Salter, A. (2007), New Technologies for Future learning - Providing training options in bushfire behaviour training.	AFAC Conference, Hobart, Australia.
Report and presentation to end-user	Salter, A. (2009). Report 1 - Approaches to training the General Bush fire-fighter: Report for Department of Environment, Land, Water and Planning. Presented, August, 2009.	Department of Environment, Land, Water and Planning's' Headquarters, Melbourne, Australia.
Conference posters	Salter, A. (2010), Technology-enhanced Learning - Examining multimedia options in bushfire behaviour training.	AFAC conference, Darwin, Australia.
	Salter, A. (2009), Simulation-based training – Examining New approaches to 'bushfire behaviour' training.	AFAC conference, Gold Coast, Australia.
	Salter, A. (2008), Technology-enhanced Learning - Examining multimedia options in bushfire behaviour training.	AFAC Conference, Adelaide, Australia.
Other	Presenting an introduction to my colleagues at the Faculty of Education and other faculties at University of Tasmania (October, 2009).	University of Tasmania

3.6 Strategies used to evaluate the research

Validity, reliability, triangulation and credibility are important conditions needed for quality case study design (Yin, 2009; Shenton, 2004; Patton, 1999). Constructs and corresponding techniques developed to counter any possible design weaknesses are outlined here. How these are applied to the research is then examined.

First, *construct validity* is the requirement to utilise the correct measures for the concepts being studied. Yin (2009) outlines two tactics that are available to increase construct validity when conducting case studies. These two processes ostensibly pertain to the data collection phase and include “the use of *multiple sources of evidence* [and] establish[ing] a *chain of evidence*” (p.42). Providing a clear *chain of evidence* increases the reliability of the study by providing a way for an external investigator to “trace the steps in either direction, from conclusion back to initial research questions or from questions to conclusions” (Yin, 2009, p. 105). This is achieved by making the links explicit between the questions asked, the data collected and the conclusions drawn. In addition, providing detailed accounts of data collection strategies, the range of sources utilized as well as indicating the data collection circumstances also contributes to the thoroughness and accuracy of this phase (Gibbert, Ruigrok & Wicki, 2008; Yin, 2009). The advantage of using *multiple sources of evidence*, which includes using different data collection strategies and different data sources, is that it allows the researcher to look at the same phenomena from different angles. These approaches add to the reliability of the research as they allow for the development of convergent lines of inquiry or a process of *triangulation* (Yin, 2009; Patton, 1999; Denzin and Lincoln, 1994).

Patton (1999, p. 1197) identifies different types of *data triangulation* as key strategies for reducing systematic bias in the data. Three of these strategies, *triangulation of data sources*, *theory triangulation* and *investigator or analyst triangulation*, involve checking findings against other sources and perspectives. *Data source triangulation* involves comparing and cross-checking the consistency of the information derived at different times and by different means - for example, comparing observational data with interview

data or comparing the perspectives of people from different points of view. The aim here is to gain consistency in overall patterns from different sources. *Theory triangulation* involves using “different theoretical perspectives to look at the same data, [with the aim of] understanding how findings are affected by different assumptions and fundamental premises” (Patton, 1999, p.1196). *Investigator or analyst triangulation* provides the means to assess more directly the reliability and validity of the data obtained and a common approach at the analytic stage is to have those who were studied to review the findings or at the composition phase, having the draft case study report reviewed by key informants (Yin, 2009; Patton, 1999). Patton (1999, p.1193) argues that “by combining multiple observers, theories, methods, and data sources, researchers can make substantial strides in overcoming the scepticism that greets singular methods, lone analysts, and single-perspective theories or models”.

Triangulation also contributes to the credibility of the research. Credibility, like internal validity, is concerned with seeking to ensure the study measures what is intended (Shenton, 2004). Merriam argues that in qualitative research the definitive question related to credibility is; “how congruent are the findings with reality?” (Merriam, 2002). Strategies used to build credibility include;

- Providing thick description of the phenomenon under scrutiny;
- The adoption of appropriate, well recognised research methods;
- The development of familiarity with the culture of participating organisations.

Gathering detailed descriptions and providing rich accounts of the phenomena being investigated helps to build an accurate observation of reality (Denzin and Lincoln, 1994) as well as conveying critical case details of actual situations and their contexts (Shenton, 2004, p.73). Providing these thick accounts in the research report also presents opportunities for the reader to make decisions regarding the relevance of the data and findings to other settings (Merriam, 2002). As case studies are highly context and case dependent, research methods that keep findings in context are important (Patton, 1999). This is particularly important in the data analysis stage as data segmenting can lead to loss of contextual relevance (Tesch, 1990). Case study credibility also relies on building depth

of understanding of work cultures and the establishment of a relationship of trust between the parties (e.g. the researcher and the participants). These research goals can be achieved by “prolonged engagement” with organisations and participants, scrutiny of a range of organizational documents and participation in reciprocal activities (Shenton, 2004, p. 65). Table 8 provides a summary of the case study qualities outlined above.

Table 8: Summary of case study quality measures

CASE STUDY QUALITY CRITERIA	STRATEGIES TO BUILD INTO RESEARCH DESIGN	AUTHORS
Validity and reliability via thorough data collection, recording and documenting procedures	Construct validity and reliability can be enhanced by; <ul style="list-style-type: none"> • Using multiple sources of evidence, • Establishing a chain of evidence and • Ensuring thoroughness and accuracy in data collection, recording and documentation. 	Yin, 2009; Gibbert et al, 2008; Patton, 1999; Denzin and Lincoln, 1994.
Reliability and consistency via a range of triangulation processes	Triangulation of data sources; theory and multiple analysts helps to test for reliability and consistency. Specifically, these provide opportunities to; <ul style="list-style-type: none"> • Compare and cross-check data, • Examine the consistency of different data sources, • Use different theoretical perspectives to review findings and interpret the data, • Key informants review draft case study report (i.e. relevant dissertation chapters). 	Yin, 2009; Patton, 1999.
Validity and credibility via other processes	Providing thick description of phenomenon under scrutiny. Adopting appropriate research methods; e.g. findings ways to maintain data contextuality. Developing familiarity with participants’ culture via; <ul style="list-style-type: none"> • Scrutiny of organisations documents, • Prolonged engagement in the field, • Establishing trust and participating in reciprocal activities. 	Shenton, 2004; Merriam, 2002; Denzin and Lincoln, 1994; Tesch, 1990.
Establishing audit trails to build transparency and opportunities for replication	Case study database (a summary of the database with a list of all available documents, interview transcripts, archival data, etc.).	Yin, 2009.

These criteria relate to this study in the following ways. To ensure the validity and reliability of the process, all interviews and observations were recorded by audio and/or video tape and full written transcriptions were undertaken. The chain of evidence in the findings chapters can be clearly traced back to the data obtained.

Triangulation processes utilized to achieve reliability and consistency involved comparison of interview data with observations, involving the responses of trainees, trainers and other stakeholders. During interviews, statements were frequently paraphrased by the researcher to confirm meanings and opinions expressed. Patterns identified were matched to those reported by different authors and informants. Thick description of the training process has been maintained throughout the dissertation.

Other strategies to enhance the credibility of the research involved familiarization with the training culture via attendance at a state-wide curriculum review seminar and immersion in written training materials and documentation. Feedback from stakeholders was obtained via several presentations of initial findings to industry forums. A summary of these strategies used in this research is provided in Table 9 below.

3.7 Limitations of the study

The fundamental limitation of my study reflects the concerns raised about single case studies, and case studies in general, in relation to its *generalizability*. Particularly, about how *generalizable* or *transferable* the findings are in relation to their *fit* to contexts outside the study. Above I make a case that my study fulfils some conditions towards transferability, particularly in its aim to meet *representative or typical* case objectives, e.g. typicality via a national curriculum framework for training bush fire-fighters and typicality in relation to current demands required of bush fire-fighters in Australia. To these ends, I have aimed for thick descriptions and providing details of the case study so that readers can decide for themselves how relevant the findings are to their own contexts (Stake, 1995). However, I am cautious to the degree to which the level of universality can be claimed.

Table 9: Summary of strategies used to meet various aspects of evaluation

CASE STUDY QUALITY CRITERIA	STRATEGIES ADOPTED IN THIS RESEARCH
Validity and reliability via thorough data collection, recording and documenting procedures	<p>The findings chapters will show the chain of evidence presented which is grounded in the empirical data;</p> <p>Use current technologies to improve the quality of the recordings (e.g. use of skype);</p> <p>Audio-tape and videotaped recordings and full transcriptions undertaken.</p>
Reliability and consistency via a range of triangulation processes	<p>Comparison of data collection in interviews with observations;</p> <p>Comparison of responses across phases; regions;</p> <p>Member checks on dissertation;</p> <p>Extensiveness of use of data to demonstrate themes from perspectives of stakeholders (trainees/trainee; comparison of comments between sectors and across Centres);</p> <p>Pattern matching (matching patterns identified to those reported by other authors) different types of informants and different sites.</p>
Validity and credibility via other processes	<p>Intensive fieldwork and attendance at the state-wide curriculum review workshop provided ample opportunities to become familiar with the training culture;</p> <p>Tracking my ongoing learning with written memos also helped me build a deeper sense of the training;</p> <p>Paraphrasing during interviews to clarify opinions and my interpretation of these;</p> <p>Presentations to industry forums about findings (Salter, 2012, 2011, 2010a, 2010b, 2009a, 2008, 2007);</p> <p>Report prepared for stakeholders based on data (Salter, 2009b);</p> <p>Thick description provided throughout dissertation.</p>

On this level, Lincoln and Guba (2002) advise the following.

It is far easier, and more epistemologically sound, simply to give up on the idea of generalization. If the generalizations are accepted, they should be as indeterminate, relative and time and context bound (p. 32).

This is particularly prudent in relation to part of the case that examines a teaching and learning practice that marks a shift from the more traditional approaches used in the past. It will be shown in chapter 8 that the simulation-based approach that uses the bushfire simulation table, which was being used for the first time in the observed training, provides opportunities for learning. Investigating more deeply the particularities of the enactments of this learning approach, and the trainers' attitudes concerning how expertise is formed and modelled to novice learners, is where the more *revelatory* elements of the case reside. Stake calls this as the point of "coming to understand its activity within important circumstances" (Stake, 1995, p. *xi*).

Therefore, although findings from this study cannot be generalised in the traditional sense, they provide a significant route to knowledge (Flyvbjerg, 2004). For example, in the above case, and as it will be shown in chapter 8, through analysis and reference to formal learning theories, theory building is enabled.

Another possible concern is that only one organisation's training context was studied and as the study is context-bound this could restrict generalisation to the boundaries of the case. However, as the training regimes of other organisations are similarly bound to the curriculum and the *Public Safety Training Package* of the *Australian Vocational Education and Training body*, it seems reasonable to infer transferability of the findings.

A second limitation is that there is a gap between the data gathering period and the final revision of this thesis. This has the potential to affect the generalisability of the findings. It should be noted, however, that industry personnel were consulted in the final write up phase and are still (as at 2016) expressing interest in the findings and a desire to engage with the researcher. It seems from these continued conversations with key trainers who

participated in this study and are still in their training roles that issues discussed in this thesis are still pertinent and the same challenges remain.

3.8 Conclusion

This chapter has outlined the research methodologies, strategies and design used in the study, including procedures, participants, data collection tools, data collection and analysis methods, and data credibility issues. The research design for this study was a single case study, analysed largely through interpretive, qualitative methods. Further it also set out the several stages involved in the design and development processes of the research in this study.

The following chapter examines the bush fire-fighter curriculum, its key learning goals and challenges in delivering the training package.

Chapter 4

Examining the bush fire-fighter curriculum - key learning goals and challenges

In Australia, the minimum training required to work as a bush fire-fighter is the *General Bush fire-fighter*¹³ training course and a large proportion of bush fire-fighters operating on the fire-ground are trained only to this minimum level of readiness. The training usually comprises a week-long course that teaches safety rules and guidelines, operational procedures and theoretical information about *bushfire behaviour*. The course is relatively brief and largely conducted in a classroom but at the end of the training novices are qualified to fight bushfires. Given this relatively short training in which trainees have little or no direct contact with active bushfire conditions, questions arise as to whether this degree of readiness remains acceptable.

This competency-based training course is established under the *National Public Safety Training Package* and is supported by the fire and emergency industry which now plays a central role in shaping the training and its curriculum (see section 1.2.6). The core intention of this training is to achieve greater workplace safety for bush fire-fighters alongside a commitment to build workforce capacity when responding to bushfires. This is critical as bush fire-fighters work in dynamic environments which are cognitively and physically challenging.

Considering these concerns regarding the preparedness of trainees, and the demands on the bush fire-fighter skill base, it is important to investigate how the *General Bush fire-fighter curriculum* is attempting to meet the core intentions of the training. The aim of this chapter is to investigate what underpins the curriculum for bush fire-fighters and to

¹³ The name of this entry-level course varies from agency to agency. For the purposes of this thesis, I will refer to the entry-level course as the *General Bush fire-fighter course*, as this is the name of the course given by the agency studied.

examine the challenges of organising and delivering the curriculum and its core learning goals. To this end *research question 1* is as follows:

- This chapter asks; How are bush fire-fighter learning goals for entry-level bush fire-fighting currently organized in the curriculum and what are the challenges in delivering this curriculum?

The chapter provides:

- An investigation of the bush fire-fighters' national accredited training and its curriculum, including its core goals and intentions (section 1).
- An investigation of how this curriculum is applied at agency level (section 2). It considers the bush fire-fighter recruitment process - who are being recruited and what roles they will fulfil - and how the training is organised and what teaching approaches are being used. This section concludes with an analysis and discussion of the *General Bush fire-fighter* learning goals as stated in the curriculum.
- An examination of the challenges in organising and delivering the curriculum. This includes an investigation of the demands it places upon trainers and the extent to which their roles and identities are shaped by these demands (section 3).

A range of methods were used to investigate the curriculum including the examination of curriculum documents and review of trainee recruitment data; surveys and trainer interviews; observations and interviews conducted at curriculum review sessions; analysis of course-work structure and assessment practices.

4.1 The bush fire-fighter curriculum and its key goals

As discussed in Chapter 1, learning for the workplace has been generally assumed to consist of a formal, structured sequence of instruction directed towards codified endpoints such as the performance of specific tasks or roles within an organisation. This assumption is reflected in the codification of *competency-based training packages* such as that which presently forms the basis for entry-level training for volunteer and career bush fire-

fighters. Novices are provided with instruction, are tested and their competencies and knowledge assessed. The learning which occurs can be defined as *accredited learning*.

This section provides an examination of the national accredited training system for bush fire-fighters, its core responsibilities and goals. It starts by providing an overview of the key components of the training system and the role and contribution that the emergency and fire industry makes in supporting the curriculum. This section then examines how these curriculum goals are shaped within the competency-based training package. The concluding sub-section, outlines additional responsibilities and obligations required to participate in delivering this curriculum.

4.1.1 Examining the national accredited training system

For bush fire-fighters, the minimum requirement to operate in the field is the *General Bush fire-fighting* accreditation, consistent with the *National Public Safety Training Package* which outlines the industry-wide qualifications and competencies required. This formal bush fire-fighter training is aligned to Australian Qualification Framework (AQF) National Competencies. As such, if bush fire-fighters move outside the state in which they received their training, or are involved in operations in another state, their accreditations are generally recognised by other fire services and land management agencies throughout Australia.

Fire and emergency services, and other registered training organisations, offer a range of nationally accredited training, under which there are five levels of vocationally based qualifications (i.e., Certificates II and III and IV, Diploma and Advanced Diploma). All training is carried out by qualified training officers. All career bush fire-fighters receive nationally accredited training from the Public Safety Training Package and they undergo regular reviews. All bush fire-fighters who are involved in fire-fighting are to complete core units contained within Certificates II and III in Fire-fighting Operations. For those bush fire-fighters who wish to undertake leadership roles, including leading training, attainment of Certificate IV qualification is required.

The national Fire and Emergency Service's accredited training system corresponds with its core responsibilities, which include providing protection to public safety. This curriculum also aligns with national competencies which lists the minimum prescribed performance competencies applicable to each bush fire-fighting role, from volunteer crew member to incident controller. Workplace safety is a major focus for the structure of these competency hierarchies.

At the national level, this training is supported by the *Australian Fire Authorities Council (AFAC)*, which is actively involved in developing fire qualifications within the Public Safety Training Package. The council offers seminars, forums, workshops and specialist courses concerned with bush fire-fighters' health and safety, safe decision making and enhancing incident management teamwork. This commitment to build workforce capacity when responding to emergencies is also supported by AFAC's *Learning and Development Group*, which consists of a representative group of educational and training leaders from member organisations across Australia. The *Learning and Development Group* aims are to provide "leadership in best practice in learning and development through innovation, collaboration and an ongoing commitment to professional development" (AFAC, 2013).

These industry-wide goals are reflected in the various bush fire-fighting agencies application of *the competency-based training package*, and the aims and goals that underpin this curriculum is examined next.

4.1.2 Examining the core curriculum goals of the entry-level bush fire-fighter training package

The core components of any educational curriculum are traditionally expressed in terms of aims, goals and objectives. The *aims* are general statements that provide direction or intent to educational action. *Goals* are statements of educational intention which are more specific than aims and *objectives* are detailed statements, such as those against which students might be assessed.

The *aims and goals* of the *General bush fire-fighter* competency-based training are stated in the following extract taken from the teaching materials:

The *Department of Sustainability and Environment*¹⁴ General Bush Fire-fighter Assessment is designed to provide consistency in the skills and abilities of bush fire-fighters across the Department as well as to be consistent with National Competency standards.

This course aims are to provide trainees with the necessary skills to be safe and competent fire fighters. The core learning goals include developing competence in fire-ground safety, operating communication and other fire-fighting equipment and basic knowledge of *bushfire behaviour*.

Thus, there is an aim to develop a consistency of skills across the entry-level bush fire-fighter cohort and to develop the skills and abilities of bush fire-fighters to be consistent with National standards. The course aims correspond with the intent of the national curriculum to build the skills necessary for individual bush fire-fighters to operate safely and competently.

As stipulated, the learning goals include developing competence in fire-ground safety, operating equipment and knowledge of bushfire behaviour. Clearly, knowledge of bushfire behaviour is an essential component of the bush fire-fighter skill and this is articulated in the learning aims of the *bushfire behaviour unit* within this course (see Table 10 on the following page): “understanding the fundamentals of the burning process will be important to us in making decisions about what is safe and effective in fire-fighting operations”. This accords with the officially stated aims of the bush fire-fighter training package, which expresses a concern to impart theoretical knowledge to underpin the practical competencies specified for the training. The science of *bushfire behaviour*, the dynamics of combustion in relation to wind, fuel and topography, can be considered as the core element on which bush fire-fighting strategies are determined, an understanding of which should accompany the acquisition of all the practical skill sets.

¹⁴ The name of the land management agency at the time of the study. It has since changed to *The Department of Environment, Land, Water and Planning*

It is important to understand how basic bush fire-fighter training is attempting to equip novice bush fire-fighters with this foundational knowledge. An analysis of the General Bush fire-fighter learning *and assessment objectives*, as stated in the curriculum, provides additional insights into these concerns and the findings are presented below (section 4.2.4).

Table 10: The Basic Bushfire Behaviour theoretical unit learning aims

THE BASIC BUSHFIRE BEHAVIOUR UNIT AIMS
<p>This session deals with the knowledge of bushfire behaviour that bush fire-fighters need before they can work safely and effectively at a bushfire. It covers some basic principles of fire behaviour - the burning process - and how it varies according to different conditions, and some basic terminology to describe various aspects of a bushfire.</p> <p>As bush fire-fighters, you need to understand how fires behave so you can base your actions on current and likely fire behaviour because you need to:</p> <ul style="list-style-type: none"> • ensure your own safety is not threatened by the way a fire is behaving or might behave in the future; • know what is necessary to put a fire out; • understand changes that may occur with a fire and resources that can be used for its control and suppression. <p>In summary, understanding the fundamentals of the burning process will be important to us in making decisions about what is safe and effective in fire-fighting operations.</p>

4.2 Examining the context of the *General Bush Fire-fighter* curriculum

This section provides an examination of how this curriculum is applied at agency level. It considers the bush fire-fighter recruitment process - who are being recruited and what roles they will fulfil - and how the training is organised and what teaching approaches are being used. This section concludes with an analysis of the General Bush fire-fighter learning goals as stated in the curriculum.

4.2.1 The *General Bush Fire-fighter* role, the recruitment process and who are the recruits

The role of *General Bush fire-fighter* is undertaken by both permanent and seasonal contract workers. The permanent worker role is that of *Field Service Officer (fire*

operations) and the key duties include assisting in the implementation of the planned burning program and the suppression of bushfires in Victoria (this role is often referred to as ‘crew member’). *Project fire-fighters* perform a similar set of duties but are employed for several months over the fire season (many *Project fire-fighters* can be employed on three year contracts for three consecutive fire seasons). Other current staff from within the organization have opportunities to take on bush fire-fighter duties during each fire season, returning to their other main roles when appropriate. Similarly, another group of *General Bush fire-fighter’s* known as the “*Melbourne crew*” are members of this land management agency’s personnel who generally work in the organisation’s central (Melbourne) offices in various roles but who are released from their normal duties when large scale fires require additional personnel. The organisation also shares training responsibilities with its Networked Emergency Organisation partners¹⁵ and sometimes employees from these agencies may attend the *Department of Environment, Land, Water and Planning* training courses. The *General Bush fire-fighter* workforce consists of approximately 1,400 bush fire-fighters (including the field services officers and 700 seasonal *Project Bush fire-fighters*).

The *General Bush fire-fighter* training is pre-entry training course and following successful assessment, the candidate is accredited for a period of five years. During the accreditation period, the *General Bush fire-fighter* is required to perform the role a minimum of once per year in order to maintain job currency and to retain accreditation. Further training (both informal and formal) is also offered after the initial entry-level training, the focus of this study, in areas such as *4WD vehicle*, *first aid* and *chainsaw use*. Periodic *General Bush fire-fighter* refresher training (usually annually) is also conducted and all personnel including novices are required to attend these sessions. These address a range of topics including pre-season preparedness and key safety messages for the forthcoming bushfire season.

¹⁵ NEO includes Parks Victoria, the Department of Planning and Community Development, Melbourne Water and Victoria Forests. These agencies have land and water catchment management responsibilities.

Recruitment occurs annually for the *Project Bush fire-fighter* positions whilst the *Field Service Officer* positions are advertised according to need. The department typically trains between 200-400 people through multiple courses across Victoria in any given year.

Data was collected to investigate the background details of the trainee cohort. Table 11 presents a summary of the educational background of *all* Project Fire-fighters employed by the Victorian Department of Environment, Land, Water and Planning in the 2008/2009 bushfire season.

The table shows that there is a breadth of educational backgrounds in this training cohort which correlates with the trend across Australia for new recruits with a range of educational backgrounds. At entry-level to bush fire-fighting training there may be novices from rural occupations with some practical capabilities but little educational background, many of whom may be challenged by formal teaching situations, alongside university-trained land management staff who may be quick to grasp theoretical constructs but devoid of practical experience of fire.

Table 11: The educational background of Project Bush fire-fighters (PFF) for 2008/2009

COMPLETED FORMAL EDUCATION COURSE TO THIS YEAR	NUMBER OF PEOPLE COMPLETED TO THIS LEVEL	PERCENTAGE OF TOTAL
Didn't complete year 10	110	16
Year 10	82	12
Year 12	150	22
Completed (or currently undertaking) TAFE	217	31
Completed (or currently undertaking) University	129	19
Total number of people	688	100%

4.2.2 Examining the training, its organisation and the core teaching approaches

The *General Bush fire-fighter* entry-level *training* course is usually conducted over five days and occurs in September, October and November prior to the bushfire season in Victoria. The unit dedicated to organising and conducting fire training at the *Department*

of Environment, Land, Water and Planning is known as the *Learning and Development Unit (Fire and Emergency Management Division)*. The unit comprises a manager and staff based in Melbourne headquarters, as well as *Fire Training Coordinators* based at regions throughout Victoria. The coordinators and associated staff take responsibility for the training in each of these regions.

To operate at the level of regional or central training coordinators, trainers are required to have a Certificate IV in Assessment and Workplace Training or equivalent, plus relevant fire-related qualifications. There is an expectation at the *Department of Environment, Land, Water and Planning* that all trainers are experienced bush fire-fighters and alongside their trainer coordinating duties, undertake bush fire-fighter duties relevant to their rank during the bushfire season. These trainers are required to coordinate and administer the regional training, involving other local assessors and specialist instructors who may also attend these camps. Assessors include qualified local bush fire-fighters who support the training coordinators in undertaking the assessment and provide additional instructional roles such as the use of the bush fire-fighting equipment which they supply from their local depots. Assessors are accredited bush fire-fighters and it is a requirement that they have a qualification at least one above the level at which they are assessing.

At the time of the data collection, the *General bush fire-fighter* course included thirteen separate units of study that were covered during the five days of the camp. These sessions included an introduction to the following;

- The agency's role and policies, health and fitness, preparation for deployment and cultural heritage, teamwork;
- Suppression equipment, map reading, use of aircraft, radio operation; and
- Fireline safety, fire science and bushfire behaviour, suppression techniques.

Of the thirteen units in the *General Bush fire-fighter* training, trainers generally referred to the course as being divided into practical and theory sessions. The 'theory' was taught in classrooms and trainers used a lecture-style delivery supported by *PowerPoints* and video presentations.

The “practice” or “practical” sessions were mostly conducted outdoors where trainees were introduced to the techniques for using equipment and machinery (rake-hoes, pumps, radio communication, etc.).

Assessment was the third major component of the camp, which included written, oral and practical components. The practical assessment usually consisted of practical demonstrations of the trainees’ abilities to operate various equipment and other practical techniques they need to know. The theory assessment consisted of a written assessment component and an oral assessment (where trainees were asked several questions which they were required to discuss with the trainer/assessor).

The time allocated to these three components varied in the three camps observed and a survey of the proposed schedules for two of the camps is provided below (a timetable was not available for the second camp). A summary of the hours spent in the theory/practice/assessment parts of the course across the two camps is provided below (Table 12). The average time allocated to each of these instructional components at both these camps is shown in Table 13. This table shows that 69% of the training time is spent in classrooms where instruction and assessment is undertaken.

Table 12: Time allocated to theory, practice and assessment sessions at each camp

SECTION OF COURSE	CAMP	HOURS
Theory	Camp 1	14 hrs.
	Camp 3	14 hrs.
Practice	Camp 1	13 hrs.
	Camp 3	7 hrs.
Assessment	Camp 1	11 hrs.
	Camp 3	6 hrs.

Note: This data is based on timetable times provided at the start of two of the camps. A timetable was not available for camp 2. Both Camp 1 and Camp 3 were run over 5 days.

Table 13: Average time allocated to instructional components at both camps

SECTION OF COURSE	Hours	Percentage
Theory	14 hrs.	44
Practice	10 hrs.	31
Assessment	8 hrs.	25
Total	32 hrs.	100

The higher proportion of time allocated to practical activity during Camp 1 relates to the nature of the trainee cohort, which consisted largely of city-based office personnel recruited to the “Melbourne crew”. The training was shaped to provide them with as much “hands-on” experience as possible. One trainer described why this was a goal for these trainees;

I would have said that the practical [training] was our aim. We figured we would do much more practical [exercises] than a normal camp because these people in their day-to-day work wouldn't get much practical know-how. They would be around reading and the theory stuff [Trainer 04].

Within the context of the course objectives, the training programs observed were modified to suit the different needs of participants. In this camp, for example, the participants were essentially office workers who were training to become members of the crew known as the “Melbourne fire crew”. This crew was formed to provide an ancillary bush fire-fighting workforce in order to bolster regional crews. For example, they might be called on to help relieve local crews if a campaign continued over several days. For “Melbourne fire crew” camp, the training was shaped to provide them with as much “hands-on experience” as possible.

In the other regional camps, this was a smaller component of the training, as most of these trainees would be joining the local crews at the

end of the training but there was greater emphasis on involving local crews in the practical training with machinery and equipment, alongside the trainers, so that the trainees could get to know the local crew members they would be working with as well as the particularities of local equipment [Trainer_04].

This latter comment points to the practical and skill based components of the course work.

4.2.2.1 Approaches to training and learning supports used in training

In the introductory literature provided to trainees, the *Learning and Development Unit* describes the approach to training as one “using a wide variety of flexible delivery methodologies and learning resources”. Table 14 provides a summary of these methods.

Table 14: Extract from trainees’ introductory booklet describing training methods

CLASSROOM APPROACHES	ONLINE RESOURCES
<p>Central and regional training workshops combine ‘class-room’ learning with practical demonstrations, scenarios, exercises and small group activities, including:</p> <ul style="list-style-type: none"> • Published learning materials, including hard-copy and web-based publications; • Video tapes, DVDs, CDs; • Mentoring/coaching; and Online courses 	<p>Website/E-mail support: Log-on to the <i>Department of Environment, Land, Water and Planning’s</i> intranet site http://Inform, launch Fireweb. These pages contain plenty of very useful information and links to support your learning</p>

In addition, the unit provides an online ‘*Basic fire awareness*’ course which provides opportunities for trainees to study as a precursor to the *General bush fire-fighter* course. The key material used to support this curriculum is the “*Wildfire Bush fire-fighter Learning manual*”. This manual extensively covers a range of information across its thirteen chapters (298 pages) and was developed by the participating agency in conjunction with the Country Fire Authority. All novice bush fire-fighters are issued with the manual.

4.2.3 The demands of implementing the curriculum

The *General Bush fire-fighter* curriculum is supported by two documents, the manual and the training package. The manual was developed by the *Department of Environment, Land, Water and Planning* in conjunction with the *Country Fire Authority* and is provided to all trainees. It provides a reference for trainees during the training but trainees are also informed that the manual will provide a compass point for the work they will do in the coming fire season and beyond.

The training package consists of a set of '*PowerPoint*' slides and associated short videos accompanied by a set of trainer's notes and the assessment package. The *General Bush fire-fighter* training package is reviewed periodically in meetings conducted by the *Department of Environment, Land, Water and Planning* via a collaborative process and attended by training managers from across the state. After these meetings, central management modifies *the package* in line with the review outcomes and other externally imposed changes within the regulatory framework and the modified *training package* before it is redistributed to the regions. In addition to this review, regional trainers undertake an annual review of their training, in which they can provide feedback in relation to their concerns about curriculum and concerns raised by trainees during training and through the trainee feedback sheets.

The mechanism for ensuring state-wide consistency is via the *training package* which, with the training manual, serves as a way to standardize the curriculum across the state. Periodic updating of the *PowerPoint* slides and teacher's notes provide the concrete vehicle on which to ensure that revised practices and protocols are quickly incorporated into training from year to year.

Aside from the need to frequently update the curriculum, its overall structure appears to be fairly fixed. Trainers endorse the importance of a standardized approach across the state and they reinforce the importance of ensuring that the 'message' is consistent, aside from the local knowledge variations they may include.

We are trying to develop a [training] package that is deliverable multiple of times with the multiple people [trainers] with multiple skills [Trainer_05].

I think it's great to have the standardised training across the state and that the guys [trainers] have those '*PowerPoints*' to show them that this is what they have to cover [Trainer_05].

Therefore, this is a systems approach to supporting less experienced trainers by providing a set of *PowerPoints* to support their delivery. A senior trainer describes how this works:

There's a school of thought that says that you need to use the '*PowerPoint*' to give the structure to the content. We produce two sets of slides, one with all the dot points on the slide and this is virtually the trainer's notes on screen (this is for those who need more guidance). The other set requires fewer notes on the screen, mostly visual etc. and trainer's notes are provided, that provide in depth content that they follow or remember as they go. So, one approach used is the presenting trainer has a colleague working with him who will tick the points off that he/she covers as they go and then prompts the presenter to cover the points missed at the end [Trainer_05].

This approach, they believe, serves to ensure consistency in the quality of training. However, it tends to equate the delivery of content with quality teaching.

There is, then, a strong organizational expectation that *the training package* will be closely followed. A consequence of this content-heavy curriculum is that a large percentage of the training is based in the classroom, teaching theory and conducting assessment. Whilst trainers recognize that this mode of delivery limits their interactions with the trainees, they do not view it as a major shortcoming. Their main concern is the time constraint upon the course overall. To include all the prescribed content necessitates long periods of PowerPoint presentations.

Trainers are aware of the impact of these lengthy presentations on the trainees and report that the main complaint from trainee feedback is about the length of these sessions and the amount of information packed into them. Trainers commonly refer to this problem as “death by PowerPoint” and the main organizational strategy they adopt is to intersperse practical and theory sessions across a day, so that these theory sessions “get broken up a bit”. One trainer talked about a last-minute decision to provide a practical session in the afternoon, saying, “We tried to mix it up a bit, because they were having death by ‘PowerPoint’. It was two o’clock in the afternoon and they were just falling asleep. Yeah, and so we charged it up a bit.”

All the trainers interviewed identified lack of time for the large amount of content to “get through” as their key problem with the training. A central training coordinator involved in a curriculum review summarised the feedback that regional coordinators glean from trainee’s course evaluations in the following extract:

The two major concerns [.....] was the number of ‘PowerPoints’ in the training package and they [trainees] wanted more practical hands-on approaches. The feedback from the trainers is that the written assessment takes too long to mark [Trainer_05].

Trainers talked about “getting the trainees more involved” in the theory sessions since these are also heavily reliant on PowerPoint slides and saw the possibility of introducing new methods of teaching as solutions to this problem. Some trainers have explored other teaching methods but are generally aware that providing different methodologies may be time consuming, demanding on their resources, perhaps requiring smaller class groups per trainer and requiring the mastery of new skills. Several of the trainers were resigned to the approaches they use and perceive them as a necessary and efficient way to get across the information they need to impart.

Therefore, this content-oriented focus is concerned with what to include and whether everything is covered, rather than with the trainees’ learning experience, the quality of the teaching methods or the depth of their understanding.

4.2.4 Theoretical concerns

Given the importance of understanding the dynamics of fire science and the behaviour of bushfires, the stated curriculum goals for this theoretical unit will be examined in more detail.

The *Basic Bushfire Behaviour* unit lists fifteen learning outcomes. Two key science-based concepts underpin these learning objectives; the nature of the combustion process and the factors influencing bushfire behaviour. As noted previously, the science of bushfire behaviour provides a model for understanding how bushfires progress across the landscape. Table 15 lists these fifteen objectives.

Table 15: The basic bushfire behaviour unit outcomes

THE BASIC BUSHFIRE BEHAVIOUR UNIT OUTCOMES

On successful completion of this session the trainee will be able to:

1. Describe how materials burn.
 2. Identify the elements for a fire to exist.
 3. Describe one common method to control each of these elements
 4. Identify three methods of heat transfer.
 5. Describe the development of wildfires.
 6. Explain the terms: Point of origin, Head Fire, Flanks, Flame height, and Rate of Spread.
 7. Describe the difference between a Ground Fire, a Surface Fire and a Crown Fire.
 8. Describe what happens to the rate of spread and intensity as a fire develops.
 9. Describe Spotting and its causes
 10. Identify the three basic factors which affect fire behaviour and describe the general effects of each.
 11. List the three general factors that affect fire.
 12. List the five main fuel factors that affect fire behaviour and describe how each affect fire behaviour.
 13. List the two main topographic factors that affect fire behaviour and describe the general effects of each.
 14. List the four main weather factors that affect fire behaviour and describe the general effects of each.
 15. Describe the relationship between wind speed and direction, and the shape of a fire.
-

To examine the level of cognitive processes required of learners in this unit, an analysis of the learning objectives, and accompanying assessment questions included in the training package, was undertaken. The analysis uses Bloom's taxonomy (1956) to map these objectives against the set of hierarchical markers that reflect the expected cognitive processes needed.

Skills in the cognitive domain revolve around knowledge, comprehension, and critical thinking on a particular topic. There are six levels in the taxonomy, moving through the lowest order processes to the highest. Level 1 is *Knowledge*, at which learners should exhibit memory of learned materials by recalling facts, terms, basic concepts and answers. Level 2 is *Comprehension*, at which they should demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions and stating the main ideas. Level 3 is *Application*, at which they use acquired knowledge to solve problems. Level 4 is *Analysis*, at which the learners examine and break information into parts by identifying motives or causes. Level 5 is *Synthesis*, at which learners build a structure or pattern from diverse elements and Level 6 is *Evaluation*, at which they are required to present and defend opinions by making judgments.

The following table (Table 16) maps these levels of cognitive activity in relation to the levels of cognition demanded by the learning objectives and the assessment questions for the Bushfire Behaviour unit. The first column shows the six levels of Bloom's taxonomy (1956); the second column are the numbers of *learning objectives* against each of these levels of cognitive process. The third column provides the number of written questions to assess the curriculum posed at each level. Appendix D provides the full list of assessment questions and how each question mapped against the Blooms levels.

Table 16: The bushfire behaviour unit's learning objectives and assessment questions and their congruence with Bloom's Taxonomy

BLOOM'S LEVELS	OBJECTIVES	ASSESSMENT QUESTIONS
1. Knowledge	10	10
2. Comprehension	5	5
3. Application	0	0
4. Analysis	0	0
5. Synthesis	0	0
6. Evaluation	0	0
Total Number	15	15

With respect to the level of thinking that is expected of trainees, given that most objectives reflect an expectation of learners to remember or recall information, and that there are many items to be recalled (10 out of the 15 outcomes), it can be said that the expectation is to cover a breadth of aspects in this field. Given that only 5 of these outcomes require trainees to demonstrate some level of comprehension, it could be said that this unit aims to contribute towards building these fundamental understandings at a minimal level. There is a similar pattern for the assessment questions. This leads to the conclusion that the expectation for trainees at the end of the training period is to have a broad but not deep knowledge of fire science and *bushfire behaviour* terminology.

An examination of all the assessment questions in the written assessment test for the whole General Bush fire-fighter course shows a similar pattern, as in the following table (Table 17) which sets the questions against *Bloom's Cognitive Process Dimensions* (1956). As above, these dimensions identify the types of cognitive processes respondents would be using when answering the questions. Of the 68 questions asked, there are 48 questions where trainees are asked to recall information and 20 questions where trainees are asked to demonstrate a level of comprehension. None of the questions required the higher order processes listed in the taxonomy.

Table 17: The General Bush fire-fighter written assessment questions and their congruence with Bloom's Taxonomy

BLOOM'S LEVELS	TOTAL NUMBER OF QUESTIONS ASKED AT EACH LEVEL
1. Knowledge	48
2. Comprehension	20
3. Application	0
4. Analysis	0
5. Synthesis	0
6. Evaluation	0
TOTAL	68

Note: Example questions include: Identify three methods of heat transfer (knowledge); Describe the relationship between wind speed and direction, and the shape of a fire (comprehension).

The following section examines the demands and influence on the trainers' occupational roles and identities.

4.3 Examining the demands on trainers and some implications for the curriculum

In a discussion about changes to vocational trainers' occupational identities, Heikkinen (2003) defines traditional identities as comprising master-craftsman in his/her occupational field, member of the occupational network, guide to the occupation and gate-keeper to the occupation. The *Department of Environment, Land, Water and Planning* trainers exhibit these traditional attributes in several ways. They have experience in the work of bushfire management and mitigation and, as noted above, they are expected to maintain their bush fire-fighting roles alongside their training roles. However, the notion of master/craftsmen bush fire-fighter is not a strong mind-set in this organisation and the trainers have varying levels of experience and expertise (the minimal level being crew leader). Nevertheless, there is a degree of respect expressed by both trainers and trainees towards bush fire-fighter/trainers who they perceive to have higher levels of experience and expertise (examples of how this is discussed are provided in the following two chapters).

Additionally, as members of an occupational network, trainers must maintain up-to-date industry knowledge, especially on issues surrounding safety, constantly evolving technology and tools and changing protocols and work practices. They are expected to respond quickly to incorporate these changes into their training.

One identity posited by Heikkinen (2003), is that of guide to the occupation. This is an important factor in how trainers' roles are perceived, in that they are expected to pass on vocational skills and the cultural norms of the industry. However, as outlined previously, the trainer's role in the current context must embrace a wider range of responsibilities than that of the traditional master/craftsman.

In addition, trainers are also engaged, to a certain extent, in the traditional attribute of gate-keeper to the occupation. Because trainees' entry to employment in the organisation is via the entry-level training course, trainers in the *Department of Environment, Land, Water and Planning* are not gatekeepers in the traditional way of providing networks of contacts for avenues of employment in the industry (Palmieri, 2004, p.11). However, they can provide important information to crew leaders and others about their perception of an individual trainee's capabilities. In this way, information about competency levels might lead to either full-time employment or consideration for further advancement and training opportunities.

As discussed elsewhere in this thesis, the public scrutiny and pressure on organisations involved in bush fire-fighting is intense and trainers are involved in maintaining records of training undertaken as well as documentation of trainees' records of attainment. They can also be expected to contribute to providing evidence of training and training practices and outcomes in coronial inquiries as well as Commonwealth inquiries. For example, in coronial or worker's compensation cases, the onus can be placed on the organisation to demonstrate and account for aspects of training for individual bush fire-fighters. In an organisation which codifies the knowledge in the form of a training package, there is a risk that this can promote an attitude which gives a higher priority to ticking off specific items as having been "covered" rather than reflecting on the learning and pedagogy involved.

For bushfire trainers, the industry knowledge, which includes both knowledge and skills in bush fire-fighting and emergency work, is the focus of their training. However, as alluded to above, a third set of vocational skills which needs to be incorporated into the training relates to the knowledge and skills required to work as members of the *Department of Environment, Land, Water and Planning* workforce. These include knowledge of organisational policies which affect *trainees'* work structures and practices, as well as the wider goals of the organisation. These broader industrial concerns can be described as ensuring that employees can demonstrate competencies to “ensure production, safety, adaptability and efficiency” (Robertson, 2008, p. 4). In this sense, trainers with the *Department of Environment, Land, Water and Planning* have responsibilities beyond imparting their “vocational know-how”. Heikkinen (2003) explains this new shift in vocational educators’ identities as follows:

Instead of being proponents of their occupation, teachers are becoming providers of education and training services; instead of being co-definers of occupations and occupational life-forms, vocational institutions are becoming enterprises satisfying companies’ training (p.10).

Whilst Heikkinen is describing identity changes applying to teachers within Vocational Education and Training institutions, this can equally apply to the current identity formation of bush fire-fighter trainers in the *Department of Environment, Land, Water and Planning*. Overall, these trainers identify strongly with their corporate role as members of the ‘*Fire Training Learning and Development Service*’. This is reinforced via a range of responsibilities that are central to their service ethos, including annual audits of training, meeting quality assurance goals, keeping administration records, including compliance documentation and participating in ongoing curriculum and training package review. These responsibilities must be juggled in tandem with the trainer’s basic role as a bush fire-fighter /manager and the complicated logistics of organising training programs during the short time-frames available. As shown above, many trainers attest to the “battle fatigue” which can arise from the need to cope with multiple demands.

Whilst these multiple roles and systems are integral to their occupational identities, the role as trainer is of paramount importance. This role is defined by obligations and responsibilities to enact the *Australian Quality Training Framework* standards within their training, their responsibilities as members of a *Registered Training Organisation* and the continuing development of resources and materials for their own *training packages*. Additionally, trainers employed at the *Department of Environment, Land, Water and Planning* are required to have completed the minimum standard of a *Certificate IV in training and assessment* in order to undertake the role of trainer. Concerns about this dual identity have been expressed, reflecting tensions that arise when vocational trainers need to superimpose the knowledge and skills which encompass their industrial practice with an adequate knowledge of training and education (Palmieri, 2004; Haycock & Kelly, 2009 & Robertson, 2008). In a review of contextual pressures in vocational education, Chappell, Hawke, Rhodes, & Solomon, (2003) argue that trainers and educators are needing to be more flexible in their teaching and learning practices, as noted in the following quote, including:

Have[ing] a sophisticated appreciation of the pedagogical choices that are not only available to them but which are also consistent with the context, clients and learning sites that make up the arena in which they work. In short, the successful implementation of VET programs relies on learning specialists who have expertise and a pedagogical orientation that they are able to deploy to meet the increasingly diverse requirements of clients. VET teachers and trainers must be able to recognise and adapt their teaching and learning practices in order to respond to such diversity (p.12).

Others also argue that this type of flexibility and adaptability requires deeper levels of pedagogic knowledge across a range of skills. Studies have indicated that the level of educational know-how of vocational trainers has been compromised by several factors, including inadequacies of the Certificate IV training and assessment to prepare trainers with a strong teaching knowledge base (Robertson, 2008), pressures on vocational trainers

to keep current with industry changes (Haycock & Kelly, 2009) and pressures to cater for a growing diversity of learners (Childs, 2005). Chappell et al, (2003), conclude that whilst further curriculum and pedagogical support for trainers is required to meet these challenges, this situation “has implications for Training Packages in so far as their successful implementation is intimately connected to the quality of VET teachers and trainers” (p.13). The move to flexible learning approaches, including the development of digital and online learning, has also placed pressure on trainers to examine their current practice and to explore the ramifications of these new approaches for their teaching and learning approaches and assumptions (Salter & Bound, 2009).

In other words, trainers faced with the demand to cover all that is officially laid down in the curriculum, have little opportunity to consider what learning may be taking place or what pedagogical innovation may be desirable.

4.4 Conclusion

The focus of this chapter was to investigate what underpins the curriculum for bush fire-fighters and to examine the challenges of organising and delivering the curriculum and its core learning goals. In doing so the chapter addressed Research question 1; How are bush fire-fighter learning goals for entry-level bush fire-fighting currently organized in the curriculum and what are the challenges in delivering this curriculum? It started by examining the curriculum context for the entry-level bush fire-fighters in Australia. The key goals of the national Fire and Emergency Service’s accredited training system corresponds with this industry’s core responsibility, which is the protection to public safety. This curriculum aligns with national competencies which list the minimum prescribed performance competencies applicable to each bush fire-fighting role, from volunteer crew member to incident controller. Workplace safety is a major focus for the structure of these competency hierarchies. This is critical because the environment in which the bush fire-fighter personnel work is dynamic and ever-changing and the tasks to meet those demands are cognitively and physically challenging.

As the discussion and analysis showed there is an intention to meet these needs via a standardised training package which seeks to ensure uniformity of training, consistent with national standards of competency across the industry. This is reflected in the bush fire-fighter *training package*, in which there is a concern to impart theoretical knowledge to underpin the practical competencies specified for the training.

Vocational educational initiatives including the development of industry training packages for competency-based training have led to the use of a broader range of learning resources and delivery mechanisms and has indicated a real interest in theoretical knowledge that underpins the behaviourally based competencies (Smith, 2003). The *bush fire-fighter training package* also reveals a concern to impart theoretical knowledge to underpin the practical competencies specified for the training, especially with respect to bushfire behaviour. However, the pre-specified knowledge outcomes of the bushfire behaviour component of the curriculum, which consists essentially of the ability to recall various schema such as the “fire triangle”, may not be sufficient to achieve this theoretical underpinning. It is important, therefore, to understand how basic bush fire-fighter training is attempting to equip novice bush fire-fighters with this foundational knowledge.

The need to secure public safety and improve bush fire-fighters’ skills, has led to improvements in basic bush fire-fighter training as well as making this training more universally available. In this respect, the adoption of competency-based basic training for bush fire-fighters has arguably lead to numerous benefits, and this has been especially important for volunteer bush fire-fighters.

In addition to the above findings, several challenges in delivering this curriculum were identified. Trainers need to grapple with a content-heavy curriculum and a cumbersome and time-consuming assessment process that is highly bureaucratized. As there is constant external pressure to change elements of this content, trainers face a continuous battle to keep the curriculum up to date. These changes can range from institutional policy changes, to changes to safety practices as result of government and coronial inquiries. Trainers describe the process of responding to these changes as a sort of trainer “battle fatigue”.

The curriculum is standardized in the form of the training package to ensure that the ‘message’ is consistent across regions, as well as providing some assurance of uniform training quality. However, whilst everyone is given the same message, it could be argued that this tends to make trainers, via the teacher notes or the dot points on the screen, mere mouth-pieces for conveyance of the curriculum content to the heads of the learners. This can result in the tendency observed by trainees for presenters to mechanically read off the dot points, a monotonous, deadening process which alienates the trainees and inhibits the learning.

In other words, trainers faced with the demand to cover all that is officially laid down in the curriculum, have little opportunity to consider what learning may be taking place or what pedagogical innovation may be desirable.

All of this is exacerbated by an additional range of commitments the trainers must address, which include annual audits of training, meeting quality assurance goals and maintaining administrative records and compliance documentation. The analysis shows that a number of challenges arise from the need to superimpose these considerable organisational and bureaucratic functions upon the trainers on-going roles as bush fire-fighters and trainers. There is also a top-down push on the curriculum, so much so that curriculum reviews are about reacting to these changes, leaving little time for real reform or renewal.

It was also found that the curriculum imposes demands upon trainers beyond the traditional concept of the role of master craftsman. Trainers now require capabilities to encompass both the world of their industry and an understanding of educational pedagogy. Keeping pace with economic and social changes requires trainers to have a sophisticated appreciation of pedagogical choices available and the ability to adapt and change their curriculum and practices.

Against this backdrop, two conclusions from the analysis can be drawn. It can be concluded that, there is a clear intention to satisfy the need to provide instruction and information via a standardised training package which seeks to ensure uniformity of

training, consistent with national standards of competency across the industry. This is important as the curriculum reflects critical components needed for bush fire-fighters to operate effectively and safely.

However, the findings also reveal that there are a number of tensions between what is intended and laid down in the curriculum and how it is managed. Subsequent chapters will consider these issues in relation to the enacted General Bush fire-fighter curriculum.

Chapter 5

The trainees' perspectives of training

This chapter examines the entry-level training experience of the trainees, to illustrate their perceptions of the training, thus addressing research question 2. While the emphasis in this thesis is focused on how the curriculum is organised, how trainers enact it and what are their challenges, it is also important to consider what this means for the learners. Therefore, a brief discussion of the trainee experience is addressed. This chapter asks; What are the perceptions of trainees about learning bush fire-fighting? (Research question 2)

In order to examine the point of view of the trainees, semi-structured interviews were conducted (as detailed in chapter 3.4.5). These consisted of a range of open-ended questions which focused on how trainees thought they were progressing in the course, what aspects of the course they were finding challenging and what they were feeling confident about. The trainee interviews were conducted face-to-face and twenty-two trainees were interviewed (see Appendix E for the background details of the trainees interviewed).

There are three sections that follow and these examine the following;

- the trainee goals for the training and their perceptions of the approaches used to teach them (section 1);
- the challenges that different trainees experienced (section 2); and the
- trainees' perceptions of the assessment processes (section 3).

5.1 Trainee goals and the learning environment

The trainees had varied expectations of the camp. For many, an important factor was the pragmatic goal of getting credentials to enter the workplace, including those who needed

the *General Bush fire-fighter* qualification to operate as contractors with their heavy equipment on the fire-ground. However, for most trainees interviewed the main goal was to be able to enter their work with the skills and knowledge required to be able to work safely.

It's good they cover a lot of things because it is a dangerous and risky job and you need to know as much as possible what you will be facing. So, it's important to know, to get all that information [Trainee_03].

Of the three main components to the training, 'theory', 'practical' and 'assessment' sessions, the trainees considered the practical sessions to be most successful. Most trainees provided positive comments in relation to the practical sessions. The bulk of these comments indicated that they could see how useful they would be for the work and what they would be doing as bush fire-fighters and appreciated opportunities to experience aspects of 'real' bush fire-fighting as a component of the learning environment. For example;

As we were there, we were using things that we would be working with, like the drip torch and rolling up the hose and using the rake hoe and the various other tools [Trainee_01].

Some noted the value of the more authentic practice experiences.

On Tuesday, we actually went out into the catchment and cut a line through the bush...so, physically-demanding work and getting used to what we would essentially be doing on the job and I think this was most beneficial in terms of trying to teach you how you'd react on the fire-ground rather than just training and pumping water from the station [Trainee_06].

Trainees also found the collegial and professional approach of the trainers to be positive. A number commented on how they valued the trainer's expertise.

They're patient, they'll go over things. You can ask a dumb question, it doesn't matter. There are no problems with any of the instructors' understanding [Trainee_07].

Most trainees recognized the value of trust, good communication and team work and some expressed concern about the relatively short time spent on physical activities, fitness and developing their skills to work in teams.

A little more of that team-building and perhaps a little more exercise/fitness activity could be worked into the program [Trainee_03].

While most trainees found the practical components of the course satisfactory, one expressed concern that there was not enough practice, as follows:

However, I mean we could be called to a fire on Monday [laughs nervously] so you know I would have thought that stepping outside this training program would have given us the basic skills, much like the soldier coming out of basic training learns to use the rifle, know how to pull it apart and put it together, know how it all works. [Interviewer: You seem to be saying that a lot more drill is needed?] Yes, I agree. The problem is that we spent much too much time in the classroom and this job is a practical job and therefore it requires a lot more practical hands-on learning [Trainee_09].

Trainees were less impressed with the '*PowerPoint*' classroom presentation sessions, which they described as causing the greatest level of frustration. Half of the trainees interviewed cited negative responses to these '*PowerPoint*' sessions and a few identified aspects of the videos as problematic. These two components made up the bulk of the negative responses expressed about the training overall. The main comments were that the '*PowerPoint*' sessions were monotonous, or repetitious, that trainees experienced difficulties concentrating and that there were "too many '*PowerPoints*' to sit through". Similarly, 'Boring, annoying, too long, too many', were the aspects that they found

problematic with the videos. Only one trainee criticized the quality of some of the videos and another noted a tendency of some trainers to verbally repeat the content of the '*PowerPoint*' visuals. One trainee summarised the classroom instruction, as follows:

It's not so much the '*PowerPoints*' [being the problem] as the person presenting them. People rely too much on the dot points [on the *PowerPoints*] and they get into this rhythm of reading out the dot points and then making a very short comment before moving on to the next dot points. It tends to lack flow and you don't get that personal touch from someone. Because they rely on it too much, interest tends to flag and it can become quite dull and the learning experience...there's a lot of repetition as well [Trainee_10].

However, some aspects of the theory sessions were identified as more successful. Many of the videos were well received by a number of the trainees, some commenting that the DVDs, graphics, animations and photos provided good illustrations of points being made. Trainees also found photos, video and stories of 'real-life' bush fire-fighting more engaging and considered that these helped them to make better connections with the points being made and the work they would be doing on the fire-ground.

Well, a PowerPoint with lots of photos is better than a more abstract delivery but actually going off and doing stuff is better again [Trainee_04].

A number commented on the confidence and knowledge of the presenters and there were very few criticisms, if any, about this aspect.

In sum, the trainees' goals were to enter their work with some sense of the skills and knowledge required to work safely. To this end they found that the practical exercises, the trainers' level of expertise and the collegial and professional environment created, as well as the videos and other media used in presentations, helped them move towards their goals and to connect the learning to the work they will be undertaking. Some trainees also

thought that more team-building, fitness activities and bush-based activities would improve the training experience for them. The classroom '*Powerpoint*' presentation sessions were generally a negative experience for trainees who cited difficulties concentrating in some sessions which they found monotonous and/or repetitious and too long, with too many PowerPoint slides.

5.2 Challenges that trainees experienced

As discussed in the previous section, when asked whether they thought their learning needs were being met, several trainees commented on the value of having access to the trainers' expertise and their sharing of experiences as a positive component of the learning environment and that this contributed to their confidence with the curriculum requirements. As discussed above there was generally a greater level of satisfaction with how the practical component of the coursework was approached than with the delivery and the content of the theoretical components. Whilst many of the complaints consisted of concerns about the duration of the 'theory' sessions and their difficulties with maintaining interest, several talked about the cognitive challenges of these 'theory' sessions.

Some trainees made comments about problems deciding the importance or relevance of some of the content and five trainees talked about the problems they experienced with too much information to digest or with information that was too "abstract".

Is this just general information or is it something we really need to remember? Because there's a hell of a lot to remember anyway
[Trainee_18].

How well the course responded to the diversity of the learner group was difficult to gauge. During observations of the training the researcher noted several occasions when individual trainees with literacy difficulties were sensitively identified and given one-on-one assistance during the written assessment processes. However, three of the trainees who said that they had limited educational backgrounds and struggled with literacy expressed various levels of frustration with the training and all found the lecture sessions

the most demanding aspect of the course. One expressed his gratitude in relation to the level of input and assistance he had received from trainers during the course, indicating that some trainers are seeking to use appropriate strategies for these learners. However, the lecture sessions caused the greatest level of frustration for these three trainees. One described his concern with not only the amount of text on the individual slides but also with the amount of information to be ‘crammed in’ throughout the week. (It is interesting to note that, in contrast, this trainee found the bushfire simulator session a very positive experience). Another trainee expressed similar concerns in the interview and was quite hostile about how challenging these sessions were for him.

Conversely, trainees who have more experience with lecture-style approaches to learning didn’t experience the level of frustration discussed above:

That’s alright for me. I can handle it. If I find things interesting I have no problems to concentrate and digest lots of PowerPoints [Trainee_14].

However, they did articulate frustration with the overall structure of the course.

In one presentation they may talk about very big picture stuff and then occasionally mention what you need to know – that there’s stuff we don’t need to know and stuff we do need to know... and it’s been left to us to separate this information out, where that information is and what’s important to us. Now it is important to know there’s a briefing tomorrow for everyone at 7am and we should go there - but do we actually need to go there? There’s a *vagueness* [my italics] ...does this matter to me? That [is what] people have to struggle with [Trainee_04].

Another trainee suggested addressing this issue by restructuring the coursework.

On the one hand you’re trying to work out what will the bloody pump do and then someone comes with all this bureaucratic nonsense that we have to try and remember. So maybe it needs to be a bit more focused on what we need to do. Or maybe you have a more structured way so

that at the beginning of the week you have the big picture...this is how incidents are controlled, these are the people in charge, the hierarchy and then you get into the business of this is what you need to know because you've got that as a basis, knowing that you'll get commands from these people...but at the moment it's all a bit of a mix and match and a bit confusing at times [Trainee_11].

For this trainee, the problem is that the training is not foregrounding the fundamentals of what they see as the work role, without which other messages, such as bureaucratic protocols, can swamp these key elements.

To some extent these latter comments reflect the priorities of many of the 'Melbourne crew' trainees, who have either graduate or postgraduate qualifications, some holding senior administrative roles in the organisation. Their concerns with "big picture", higher order concepts may reflect the way they approach learning and how their own preoccupations conceptualise the work role. However, this group of trainees recognised the importance of the practical components of the course and that these practical components of the work role would challenge them. One aspect of this is access to the language of the culture they will be participating in.

It would be good to have a glossary at the start – the trainers know what they mean but there are too many new words and it's all a bit confusing. Words and terms like 'slip-on', 'pig', 'stag', 'widow-maker' for example [Trainee_10].

The background and prior experience of trainees shape their critical rationales and the varying viewpoints reflect the diversity of learners that this learning environment needs to cater for. While the comments above may reflect the preoccupations of higher performing individuals, their critiques of the curriculum reinforce the previous evaluation of a heavily content-laden curriculum in which information is presented as isolated knowledge bits, leaving the learner to work out how to "mix and match". The diversity of learner backgrounds includes some trainees who grapple with problems of literacy and limited

prior access to the culture of ‘school learning’. There are also some trainees who already have high levels of practical, hands-on experience with bush fire-fighting (e.g. bull-dozer drivers seeking formal fire-ground accreditation) but limited education. Some trainees had high expectations for how the curriculum was delivered and could articulate a more sophisticated level of knowledge about training and learning as well as self-knowledge of their own learning not accessed by the dominant instructional approach.

5.3 Trainees’ perceptions of the assessment process

Trainees expressed varying reactions to the content and processes of the more formal assessment and some were concerned about their ability to succeed. In general trainees found assessment around the practical components of the curriculum satisfactory. One trainee described how the trainers supported the assessment process, as follows:

They asked us ‘Are you comfortable doing it?’ and they gave us the assessment sheet which we were able to read through while waiting to do it so I guess if something had popped up there which I wasn’t happy with I would have probably said, ‘I’m not happy to do that now. I’ll do it later’. But with the ones I’ve had so far I’ve been confident enough to think that even if a tricky question comes up I’ll be able to problem-solve. You get to the point where you understand the equipment enough to be able to suggest how you might get around the problem. I felt confident to do that – but not pressured into it. I felt I could have spent more time learning had I wanted to [Trainee_14].

In general, trainees found that the practical skills sessions provided adequate time to understand and familiarize themselves with the equipment and saw a direct and obvious link between what they were learning and what they were being asked to demonstrate in the assessment. This aspect of the training only became problematic if there were problems with the training during the practical sessions. For example, one trainee was concerned about the teaching processes which he found to be inadequate.

The radio assessment will be [challenging] because I haven't had much practice yet and in the session, we had there wasn't much opportunity to practice...getting used to speaking in radio-speak is something that takes a bit of time...the formalities of how you make your call, how you call someone else, calling out, signing off at the end, handing over to the other person to speak – that formality takes a bit of getting used to [Trainee_08].

Whilst trainees found the practical assessment processes helpful to their learning, they were less convinced that the formal assessment processes were suitable. There were limited opportunities to gauge their own progress during the course and some perceived a lack of clarity in the assessment content. They were also concerned about the high stakes hanging on the outcomes of the assessment and some worried that their individual progress during the 'theory' sessions was not a trainer concern.

No, they don't seem to be checking my progress...if I was a trainer I would be seeking it somewhere along the line. I'd be looking for some sort of understanding along the way [Trainee_03].

However, many found the assessment content undemanding and typical comments included, "I breezed through the [oral] assessment" and "I'm doing well with the assessment so far." Trainees generally found the training-assessment process to be a positive experience.

What I've noticed about the sessions here over four days is that they tend to be short and succinct pieces of information that you can absorb quite easily and they've broken up the assessments and the practical sides of it so you can absorb it and refresh it in your mind. So you do learn it better and you're not sitting back and wondering what's for tea tonight, you're not getting distracted. I think breaking it into short sessions is certainly a help to me and probably to those who are less

academically focussed...to have it more practically involved. I certainly think that's a good sign [Trainee_15].

They've done a good job. It's been comprehensive and detailed where it needed to be detailed [Trainee_10].

Few had any illusions that completing the training would fully prepare them for the work ahead and the need for on-going mentoring was generally recognized.

I'm sure it's going to be adequate for when I first go out in the field because I expect to be under supervision and I'm not operating without someone else who's more experienced. I'd be a bit uncertain about myself if I was sent out without a crew leader...I don't think I'm ready to be making decisions that a crew leader might have to make...I think it's been adequate; the way they've run the week [Trainee_07].

5.4 Conclusion

The focus of this chapter was to examine the curriculum enactment from the point of view of the trainees. This chapter addressed the research question; What are the perceptions of trainees about learning bush fire-fighting?

The discussion and analysis showed that trainees valued a number of key elements of the curriculum. Trainees appreciated the learning environment established in the practical sessions, which provided opportunities to actively engage in work-related skills, with scope for open discussion, questioning and hands-on practice with tools and equipment. Additionally, they appreciated the opportunities to interact with local crews who helped conduct sessions and to meet crews they might be assigned to in future. They expressed confidence in the technical knowledge and professional skills of their tutors.

The 'Melbourne crew' trainees, and other trainees who have limited bushfire experience, particularly valued the practical components of the training. As many of this cohort have limited or no rural or bushfire experience whatsoever, they appreciated the opportunities

to assimilate with crews and were keen to get as much skill-based experience as possible. Understandably, it was this group that expressed the most concern about their preparedness for work at the end of training.

Two additional findings were identified. The first relates to the challenges trainees experienced with the formal classroom sessions and the second relates to their perception of the assessment process. On the first, some found the amount of information overwhelming and many were bored by frequent repetitions in the deliveries and tended to disengage. There were few opportunities for the learners to actively participate and some commented upon this. Trainees expressed concern about a perceived vagueness in the relative importance of various components of the content presented. They had difficulty distinguishing what elements were “important” from “what’s nice to know”. Others expressed difficulties connecting aspects taught with their real-world application.

On the trainees’ perceptions of the assessment process, several trainees expressed anxieties arising from a lack of feedback on their individual progress during the course. While there was a degree of formative assessment during the practical sessions this was not the case with the classroom-based component of the course. Trainees were not required to articulate what they had learned in the theory sessions until the oral and written assessments at the end of the course. Some trainees found the oral and written assessment process demanding, and this was especially the case for trainees who had not undertaken training, or studied in a classroom context, for a long time. Trainees with limited literacy abilities particularly found the written assessment challenging.

A conclusion drawn from the analysis was that when looking at learning from the trainee’s perspective, learners tended to disengage with the training that relied on *PowerPoints* as a means of delivery and become passive. Whilst many trainees found the overall experience positive, some left this intensive 5 day-long training feeling underprepared for what they might be facing in the field.

Overall, it can be concluded that the responses obtained from the trainee interviews reflect the diversity of learning needs within the trainee cohort. As reported in the previous

chapter, this correlates with the concern trainers expressed about meeting the needs of a diverse group while seeking to “cover everything” within the relatively short duration of the training camp. This tension relates to a possible overreliance on a summative assessment process. Trainees themselves did not feel confident that they are indeed learning because they were not getting feedback on the theory sessions.

The following chapter addresses the viewpoints of the trainers conducting the course, reflecting upon the issues raised above in the light of their attitudes to the training.

Chapter 6

Examining the trainers' perceptions of training

This chapter examines the curriculum from the trainers' perspectives, addressing the following research question (3); What are the perceptions of trainers about how trainees learn bush fire-fighting?

The chapter is based on interviews conducted with trainers and observations of teaching practice during the three *General Bush Fire-fighter* training camps, augmented by subsequent trainer interviews and observations undertaken at curriculum review meetings (see chapter 3, section 4). Its purpose is to examine the perceptions of trainers towards the training curriculum and its delivery.

6.1 Trainers' perceptions of the training curriculum

How trainers see the relationship between the practical and theoretical components of the training is an important aspect of their perception of the training. While attesting to the importance of developing the technical skills of trainees with tools and equipment, they also consider that a basic knowledge of *bushfire behaviour* and bush fire-fighting strategies are essential components of the coursework. Many trainers talk about this as basic *know-how* required for the work of the bush fire-fighter. One trainer asserted that trainees who think that the practical work is all they need are usually the ones that most need the knowledge base.

They really want to do more practical but there's a couple that really need that PowerPoint because that's what they need to learn; they need the bits and pieces [Trainer_06].

It is interesting to note that for this trainer theory has implicitly become "the passport", suggesting a divide between how these two components of the course are traditionally delivered.

However, in this context, trainers commonly used terms like “*passing on knowledge*” and “*giving them the basics*” and generally perceived the traditional approach they use as sufficient to progress the trainees’ limited knowledge bases. One trainer felt that this was a relatively simple task, “Because it really isn’t rocket science”.

Yeah, well in General fire-fighter [course], because they just have to learn the basics, like the safety and health and fitness and like it’s hard to build a scenario-type approach because they have to have the knowledge to build on to start with [Trainer_02].

The PowerPoint-laden curriculum suggests that many trainers perceive the cognitive demands on trainees to be generally about recall. It appears that consideration of trainees’ learning needs is limited to this. Whilst two of the trainers interviewed expressed concern about the ability of some trainees to cope with the large amount of information provided during the camps and trainers generally were concerned about the amount of information they need to ‘pass-on’, the cognitive abilities of the learners and the extent to which the dominant PowerPoint delivery supports or impedes them was not raised or examined in any depth.

Whilst the trainers were somewhat unreflective about learners’ cognitive needs, there was an awareness of the difficulties some learners have with the teaching format, especially those with literacy issues. Trainers tend to deal with this by providing one-on-one help but don’t perceive the lecture-based teaching method as problematic for the general group of trainees, although they attempt to adapt the training to some extent according to trainees’ backgrounds and experience.

Some trainers perceive theoretical aspects of the curriculum, particularly the unit on bushfire behaviour, as *foundational* or *underpinning* and discuss these aspects as “building blocks” upon which future expertise will be constructed. However, how trainers facilitate the development of this knowledge to support the linkage between these cognitive building blocks and the future development of this knowledge toward expertise

is not clear and it is arguable that the current curriculum may not be providing the depth of foundational knowledge at entry-level upon which future expertise is to be built.

6.2 Assessment approaches used and trainers' perspectives on assessment

Assessment at the camps consisted of *written*, *oral* and *practical* components. The 'written' component consisted of a series of multiple choice and short answers questions, oral sessions were conducted in person with an assessor and the practical assessments consisted of trainees' demonstration of their knowledge of various items of equipment and /or demonstrating some elementary skill. Practical assessments were spread over the week and, as the written assessment test is quite lengthy, it too was divided into smaller parts and spread over the week in two camps but the other camp left the oral tests to the final part of the week.

Like the curriculum, the assessment is standardised training across the various regions and is delivered in a uniform way.

During reviews of the coursework, trainers expressed concerns with the cumbersome, time consuming and resource-intensive nature of the assessment process. A central fire training manager noted these concerns, as follows:

So, the major concerns from the [regional] coordinators' point of view were about the assessment. In sum the written assessment takes too long to mark and for some the oral takes too long [to conduct]. They don't have enough personnel to undertake the assessment and it eats into the time at the camps. For example, on the assessment side, if you have 30 questions in the oral, that could take an hour [to conduct, per student] - whereas the written would take an hour and half to mark.

We've agreed that we must have a written and an oral component to the assessment, region-by-region, to decide how they will approach this. Their decisions are based on the personnel available and the time

they've allocated and how they decide to approach the questions [Trainer_05].

Regional trainers are given discretion as to how to manage the assessment process. These decisions were usually concerned with integrating the assessment process within the training timetable and very few trainers expressed concerns about either the method of the assessment or its content (aside from changes relevant to changes in the teaching content). The assessments serve as a record for auditing purposes and as records of individual attainment. One trainer explained how this works.

The [assessment] paper work can be a bit of a drag.... we get audited and so we need hard copies to show the auditor and we have to hold onto the records for some of them for up to seven years. But you have to show individual learning, and if they fill out the form then you know it's their work [Trainer_01].

In effect, trainers teach and assess as they go along. They have a checklist of skills each trainee should have attained (e.g. maintenance of rake hoe) and as trainees demonstrate these skills they are marked off.

While the practical components were usually assessed on an ongoing basis, the formal written and oral assessments are primarily associated with the knowledge and information content of the course and usually occur at the end of the training. The written assessment is basically asking trainees to recall or describe something and is largely composed of multiple choice questions.

Our General Bush fire-fighter accreditation is more about knowledge not competency. It only contains 50-50, 50% of competency but it's more about knowledge because we will check your competency later on [...] so it's really the bare minimum of the knowledge aspects [Trainer_03].

This comment reflects that the written and oral assessments have the same limited depth examined above in relation to the curriculum. In the following chapter, an analysis of the written assessment confirms this trainer's perception of bare minimum requirement at this stage. In preview, the results (see section 7.3) show that in most questions in the written test, the trainees were being asked to answer a question where they had to *remember* or *recall* some information, with a correspondingly low number which required any interpretive or higher order response.

Following a training camp, one trainer summed up his perceptions of the assessment of trainee knowledge: "We never looked at their knowledge-base in depth" [Trainer_08]. Similarly, trainers indicated that estimating the progress of individual trainees during the course of the week was not a concern, as exemplified by the following comments of one of them.

But on the *General Bush fire-fighter* side of it, while we were spending a fair bit of time with those people as groups and as individuals, I'm not sure if we have said, 'Hey you are going alright or you are getting this or you are getting that?' No, and we didn't really know where anyone was up to, until the practice sessions. But I don't know whether we really need to know all of that, to know that one person isn't really there. We refocus on what we are trying to do.

So we've got them - there are up to 50 or 60 hours of training but we don't have a little milestone point at point 10 to let's see if they [are] actually getting any of this. We might check some knowledge somewhere but they are not official checkpoints [Trainer_02].

Apart from the practical sessions, the trainers were not greatly interested in *formative assessment* but tend to regard assessment as a *summative* process¹⁶ to gauge their own teaching performance. One trainer remarked:

¹⁶ In this case, an assessment providing a summation of declarative knowledge recalled by the trainee.

So I guess we don't really fuss that much about what they don't know, we are more worried about why we haven't taught them that already [Trainer_08].

This trainer sees the benefit of knowing what the trainees have recalled and understood but primarily as a means for gauging how well particular content has been covered. It is interesting to note that his comment suggests that, for trainers, how and what trainees learn bears a direct relationship to *what they have been taught*.

However, in the practical training, assessment was used in the context of mentorship, as a formative tool.

What we were aiming to achieve is to provide the group with guidance as they progressed through the week, by acting as a mentor the assessor was able to track the progress of the trainee whilst building a relationship of trust with the trainee. In both camps we conducted we got clear feedback from the trainees that they appreciated the opportunities to access the mentors throughout the course [Trainer_02].

The same perceptions informed the oral assessment component of the course.

So I think that you get a better level of understanding [of what the learners know] through the oral assessment than the written one. You find out more about what they know. Although it takes longer you get a better bang for your buck. You can ask longer, more in-depth questions and you get longer more in-depth answers and you can gauge how much they know [Trainer_02].

Another trainer was asked whether trainers should be aware of trainees' development at earlier points in the week-long course and he indicated that this is not a big concern.

So we are more assessing our own delivery. It has been delivered, then why don't they know? [...] rather than assessing whether they know it

or not at that point in time but looking at the training and saying, ‘Oh what’s gone wrong with the training? Maybe the wheels have fallen off a session somewhere. We may need to reiterate it or go over it’. So we ended up having to have a session out there, ad hoc around the tanker, about the safety around the hoses, because we realized it just hadn’t been covered. But none of that is about assessing what students know midway through the course. We are really only worrying about that on Thursday and Friday [Trainer_08].

Another trainer reflected a similar perspective when asked to sum up the training.

Yeah it went well. Nothing actually went according to the agenda [timetable] but we covered everything [Trainer_04].

Underpinning this is the notion that teaching effectiveness is essentially an issue of ‘presentation’, how well the content is delivered. In essence, the perspective is that ‘If we’ve covered it then the trainees should know about it.’ Accordingly, the solution to any learning problem is simply to repeat the message, (“We may need to reiterate it or go over it”).

These comments imply that the trainees’ reflective processes are not a concern to trainers and that the trainer’s role is simply to transmit the content to learners (some trainees expressed concerns about this aspect of the trainer delivery, as mentioned in the previous chapter). From the perspective of the trainer there is only a limited sense of the learners themselves having a role to play in the learning or that gauging the progress of the learning is critical to effective teaching. It is worth noting at this point, while maintaining this overall view, one trainer provided a different view of the role of formative assessment in the theoretical *bushfire behaviour unit* that he teaches, using the bushfire simulation table (examined in more detail in the following two chapters). In this context, the trainer acknowledged the importance of gauging and assessing learners’ progress, and that moreover, this information provided feedback which enabled him to steer the learning process in particular directions as the lesson progressed.

6.3 Instructional role, basic teaching and learning assumptions

There appeared to be a perception that “real learning” occurs post course, in the field and more experienced leaders talked about how this optimally occurs with good leadership and mentoring in early deployments. However, access to this post-training mentorship is limited by the diminishing pool of older, experienced bush fire-fighters and crew leaders in the organisation – a problem which confronts all fire agencies, as previously examined (see chapter 1), and to which we shall return in further chapters. The development and fast-tracking (to the extent that this is possible) of new expertise may require a fresh look at the nature of *General Bush fire-fighter* training at entry-level and beyond, with a revision of these basic assumptions about the nature of learning.

6.3.1 Trainers’ perceptions regarding theory and classroom instruction

The teaching of bushfire behaviour theory is subject to these same limitations (partially attributable to the time constraints of the course overall) despite the efforts of trainers to make the lecture coherent and interesting. While this portion of the curriculum may be seen as background information by some trainers, believing that “real learning” takes place on the fire-ground subsequent to the training course, others see the theory of bushfire behaviour as the foundational knowledge upon which expertise will eventually be based. Bushfire behaviour is a complex phenomenon and its teaching, even at an introductory level, warrants some innovation to enhance the learning beyond the level of an ability to recall a few dot-pointed summaries.

6.3.2 Becoming a bush fire-fighter

However, it should be kept in mind that the *General Bush fire-fighter* course is at entry-level and for many of the trainees this is their first orientation to the community of practice in which they will be participating. There are obvious limits to what can be achieved in five days, no matter how intensive the training. Trainers are unanimous in the assumption that the learning is to be consolidated and extended by the experience of participating in the practice of bush fire-fighting in the field, guided by more experienced and, hopefully, expert mentors. The richness of this subsequent experience and the quality

of mentorship will largely determine to what extent and how quickly the novice will progress to higher levels of expertise.

In other words, the training of a bush fire-fighter is an on-going process which extends beyond the duration of the *General Bush fire-fighter* training course conducted at a five-day camp. The following observations highlight the trainers' concerns about the assessment of competence in the novice's participation in the workforce subsequent to the *General Bush fire-fighter* training camp.

Some trainers question whether they are appropriately assessing competence of novices during their post-training deployment in-the-field. Currently, novice bush fire-fighters are required to complete a specified number of hours in the field in order to reach the national competency standard and bush fire-fighters carry a small red book where a log of hours is kept and completed tasks are identified. Some trainers question whether this provides sufficient information about an individual's competence. One trainer expressed the following view.

Because competency is about going out and demonstrating behavioural change, even when we have the little red book, is this really helping us to see how they have gone out on a fire? I guess we are trying to see them do things in response to certain things but it's pretty hard on the fire-line because you can go your whole life [working on the fire-line] and never really be competent. So you come home and you've lived through it to your competency because you have come home... I'm not quite sure how we are going to assess that they are fully competent [Trainer_02].

[He went on to say:]

It's easy with four-wheel driving, at the top of the hill in certain conditions they have driven with competence and it's really easy when we want them to start the pump, [for example] but knowledge of

bushfire behaviour and a knowledge of dangers on the fire-line, it might be bit hard to assess them.... so we might be a bit rough on that, I'm not sure we've got that one ticked off right... it depends where you set the bar [Trainer_02].

6.4 Trainers' perspectives on teaching *bushfire behaviour*

As previously asserted, at the core of expertise in bush fire-fighting is rich understanding of bushfire behaviour and while the novice bush fire-fighter cannot be expected to acquire this without considerable field experience, an introduction to fire science and the elements of bushfire behaviour is an essential component of initial training. The ways in which trainers address the teaching of the *Bushfire Behaviour* unit of the course becomes the principal focus of this thesis in the following sections and beyond.

As indicated previously, in the classroom, bushfire trainers have built up several ways of representing the content in this unit to assist them in teaching the subject matter. In the classroom, they use a range of media to support their presentations, including animations, small physical demonstrations, the use of the “*fire triangle*”¹⁷ and video footage of an actual fire. Trainers express several beliefs about how the use of media support learning. These include helping to build better connections for trainees with limited or no prior experience, to connect the classroom learning with the work they will be doing and to think ahead to the work role. Trainers expressed several reasons for using a variety of media in the classroom. They help the trainers to illustrate, describe and explain the basic concepts and ideas and help to engage the trainees. For example, one trainer mentioned how trainees are engaged by a particular video which shows a bush fire-fighter using a rake-hoe (the primary tool for bush fire-fighters working in remote areas) to put out an actual fire.

¹⁷ The “fire triangle” is a symbolic representation of the combustion process (see chapter 7 section 2 for a description of how this is used in the classroom).

The rake-hoe bit where the guy puts out the fire... they [trainees] would prefer to see a real fire in a video... there's that little bit of adrenaline in the whole thing [Trainer_06].

Another trainer makes a similar point.

I think that trainees enjoy video and photographs of real situations. It just stimulates their interest and gives them some idea of what's going to happen, potentially, because they don't know what it is they are going to be looking at [Trainer_04].

This trainer is referring to trainees with limited or no experience who have difficulties connecting with the information they are given. The trainer goes on to elaborate this viewpoint, as follows:

In that group [Camp1] we didn't have any [names another firefighting agency] volunteers and usually we have one or two who have fought fires, or done rake-hoe lines or worked alongside the [names their agency] or what have you. Yeah but these guys were brand new and they had no idea of what they were looking at. And it will happen out on the fire-ground. They will see a 5m high flame and you can say "if you remember your training", so you let them know if it's ticking along not to worry, it's not going to bite you. You know as long as it's not going hell for leather and when you are out there you can remind them of their training but help them deal with all their physical and emotional reactions being out there with a fire [Trainer_04].

6.4.1 Trainers' perceptions of the trainee cohort

Some trainers also expressed concern about changes in the type of trainees they are now teaching; that more frequently than before they encounter trainees who have very little real-world experience around bushfires. In some respects, the focus on providing a more

basic, introductory approach coupled with practical experience in the training reflects their concern to cater for these trainees. The variation of views about what level to pitch this part of the curriculum may reflect the concern to provide a basic grounding for these new trainees.

In some respects, it is because of this circumstance that trainers believe that trainees first need to learn the basics of bushfire behaviour before providing the situated experiences which will help make connection between what is taught in the classroom and the work they will be doing. However, it may also reflect a general perspective of some trainers that the thinking required to understand the theory of bushfire behaviour is uncomplicated and can be easily passed on or given and that providing an instructional overview, and some demonstrations, is sufficient for these novice trainees.

Also, implicit in this view is a perspective that considers novices to be incapable of thinking at higher levels whilst learning the basics. This perspective is limiting for trainees, especially in camps such as the one catering to the “Melbourne crew”, for example, where trainees may not have first-hand experience of fire but have good capacities for thinking at higher levels. Nevertheless, whatever the trainees’ prior experience with bushfires, the use of ‘media’ in the classroom and other tangible demonstrations can provide illustrations of real world examples to novice bush fire-fighters which are especially important for trainees with limited experience of working around bushfires.

The following section examines trainers’ perceptions of some of the tensions and problems of teaching bushfire behaviour and considers what some trainers perceive to be difficulties or shortcomings of the training system.

6.4.2 Perceived problems with teaching *bushfire behaviour*

Some trainers raised several concerns regarding the existing approaches to training and why they experience difficulties with teaching this subject. These include questions about how well the classroom delivery is building knowledge and understanding, limited

opportunities to include experiential learning opportunities and a perceived lack of clarity about what constitutes competence in this area.

While one trainer observed that “it’s not rocket science”, understanding bushfire behaviour does involve the science of the combustion process and the complex interactions of fuel, heat, humidity, topography and wind. In the classroom introduction to *Bushfire Behaviour*, several demonstrations are provided and various media are used to help describe and explain the combustion process and the complex behaviours of bushfires.

However, most trainers asserted that having access to real bushfires is the key to knowing more about how they behave and they attest to the importance of first-hand experience with fire for building knowledge. One said it “Can be very difficult to teach without seeing the fire, physically” and noted the paucity of simply telling trainees in presentations about the complex and dynamic nature of bushfires when “We are only engaging a couple of their senses by merely listening to somebody”.

Trainers identified several factors limiting the use of real small-fire exercises in training. These include safety issues associated with ‘live’ fire training, the logistics and costs associated with organizing these exercises, and the complications of weather and other natural conditions preventing exercises from being undertaken or making them difficult to organise in advance. An additional question concerns their efficacy for enhancing understandings of *bushfire behaviour* beyond what can be observed in close proximity to the individual trainee.

6.5 Conclusion

This chapter focused on the perspectives of trainers towards the training curriculum, the learning environments it affords, the goals underpinning the training and their assumptions about training and learning. It asked; What are the perceptions of trainers about how trainees learn bush fire-fighting? (Research question 3)

It was found that trainers expressed concerns in relation to changes to the work role and training, including the challenges associated with the more demanding work role and changes in the type of people being recruited. Trainers believe that to operate more effectively and safely in more complex conditions, bush fire-fighters need a rigorous understanding of the science of bushfire behaviour. However, the change in climatic conditions also means that the opportunities to use smaller fires or prescribed burning to train novices are diminishing. This means that there is a greater reliance on training to provide the foundations of this knowledge. However, this is made more difficult because the training cohort is much more diverse than in the past; there is a wide variation in their educational backgrounds and the level of experience, some having limited experience with bushfires and many having no rural experience whatsoever.

These challenges, and the other curriculum demands identified in chapter 4, impacts on the learning environments that they are able to create. It was found that trainers typically used a lecture-style delivery with an emphasis on instruction. Trainers are aware that trainees' find the lecture-style approach challenging and they are keen to improve this situation. However, they have a limited repertoire of approaches to draw upon, which they see as a barrier to exploring new possibilities and as they are time-poor they see lectures as an expedient and efficient way to get the curriculum across.

They were also concerned about the cumbersome assessment process they use; whilst it helps them to meet the various training obligations and maintain the minimum standards required to work on a fire-ground, some trainers are less convinced about the preparedness of trainees especially in the light of the limited prior experience of the trainee cohort.

The discussion and analysis also identified several trainer assumptions about learning and pedagogy. There are two common assumptions. It was found that trainers didn't think that they should be gauging learners' progress during the vocational theory part of the course and that assessment was seen as a *summative* activity – making sure that the students had “got it” at the end of the training. In this way trainers prioritised checking if topics had been covered, and the attitude was that if the presentation had covered the topic then the trainees should know it. The second assumption is that trainee learning only occurs if it

has been taught and conversely, that if it has been taught, learning should have occurred. This reveals a perspective of training as a purely transmissive process where learners are vessels to be filled. From this perspective, the problem of learning is about the quality of the presentation rather than the effectiveness of the learning. Therefore, it can be concluded that trainers typically use a lecture-style delivery with an emphasis on instruction rather than a model that focuses on trainee learning.

Chapter 7

Teaching the science of bushfire behaviour: two enactments

The aim of this chapter is to examine the way educational strategies are employed to teach the science of *bushfire behaviour*, including the manner in which the concepts of bushfire behaviour are communicated to trainees.

This chapter asks; How is the teaching of the science of bushfire behaviour currently enacted in the learning environment? (Research question 4)

The next two sections provide a narrative of the teaching processes used in delivery of the bushfire behaviour unit of the curriculum. These two contrasting modes of instruction include the classroom-based approach and a simulation-based approach. The first was used in camp 3 and is the traditional and typical way this unit has been delivered. The second approach was being used for the first time in camp 2. These were delivered by two separate trainers to address the same curriculum objectives of the course (i.e. the *Basic Bushfire Behaviour unit*. See Table 15 in Chapter 4 for an outline of these objectives).

7.1 The traditional lecture-based delivery

A lecture presentation has been the main vehicle used to deliver the science of bushfire behaviour component of the course. This section will consider the established, customary approach to learning in this unit, using a lecture-style delivery and referring to a set of *PowerPoint* slides and various other media provided as part of the trainers' training package.

The following provides an account of how this teaching sequence progressed in a typical *Bushfire Behaviour* presentation, based on a video recording of the session. It examines the instructional sequence and how the principles of fire science and bushfire behaviour are introduced. The account is based on analysis of the video data with some broader

observations made at the time. It is followed by an examination of the interaction between trainer and trainees, with an emphasis on how the trainer engaged with trainees via the questions he asked.

7.1.1 A narrative of the lecture-based approach

The trainer stands at the front of the group and uses a set of PowerPoint slides to accompany his lecture as well as using a whiteboard. The room is arranged with students' desks in a horse-shoe formation facing the trainer (see Figure 1 below). Trainees have a set of notes which consists of a copy of each PowerPoint slide (one to each page) with space below the PowerPoint images to make notes. The lecture lasts for about 60 minutes with the trainer at the front providing the bulk of the discussion. For the most part the trainees remain silent unless answering questions posed by the trainer. In Figure 1 the trainer stands beside the PowerPoint screen with the trainees sitting at desks facing the trainer and the screen.



Figure 1: The classroom arrangement for the lecture-based approach

There are 26 slides in this unit's training package and the trainer addresses each one in the sequence provided. The trainer starts the session by introducing himself and his bush firefighter role. He then explains how his role relates to the trainees' projected initial roles when both small and large fires campaigns are underway. He then provides a rationale for why this information is important to trainees, as follows.

Bushfire [behaviour]theory is a good topic and has some good information for you. It builds on stuff that you already know but it just enhances your understanding of how fire is going to react and behave in different conditions. This is the knowledge that you need to work safely and effectively near the fire.

The trainer then outlines the four major aspects that will be covered.

So, what the session is going to cover is the fire triangle, how fire is created basically. We are going to talk about heat transfer and its effect on bushfire behaviour. We'll talk a little about parts of a fire and terminology [trainer uses laser pointer to indicate the diagram of the parts of the fire] and we will also talk about factors that affect bushfire behaviour and three main factors that affect bushfire behaviour, weather, fuel and topography. So, we will go into those in a fair bit of detail.

These aspects are presented diagrammatically on the first slide that is presented to the trainees (see Figure 2 below).

Session Objectives

This session covers:

- 🔥 The fire triangle
- 🔥 Heat transfer
- 🔥 Parts of a fire and terminology
- 🔥 Factors that affect fire behaviour

Victoria
The Place To Be

Figure 2: The objectives of the Bushfire Behaviour unit

The trainer then starts with a presentation on the elements of fire, including the combustion process, radiation, convection and conduction. These four elements are represented in diagrammatic form on the slides and the fire triangle (see Figure 3 below), representing the combustion process, which is the focus of this part of the lecture.

The Fire Triangle

Fire requires three fundamental elements.

- 🔥 Fuel
- 🔥 Heat
- 🔥 Oxygen

Remove any one element, and the fire is extinguished.

Victoria
The Place To Be

Figure 3: The 'fire triangle' slide in the Bushfire Behaviour unit

The first fire scientific concept, the combustion process, is introduced as a fire triangle – which is also called the ‘fire tetrahedron’. The trainer then explains the different kinds of fuel in the environment, using the blackboard to illustrate his points as well as actual fuel samples (leaves, twigs and branches) illustrating the different natures of fuels. The trainer then turns back to the fire triangle and provides an explanation of the process of chemical reaction.

So, when enough heat is applied to fuel vapours are produced and in the presence of oxygen we get fire. At 270 degrees celsius or just over 500 degrees Fahrenheit applied to the fuel, that gives off vapours and then you get, uhmm, in the presence of oxygen you get fire.

He then turns to the slide with the fire triangle and asks:

How then do we control fire? Well we need to control fire by removing one of the elements from the fire triangle.

He then animates the fire triangle slide – the fire animation in the centre of the triangle disappears from the screen when each side is removed, to illustrate the notion that when an element is removed then the fire is extinguished.

...and that's the principles, ah fundamentals of fire-fighting, to remove one of those elements. Remove any one of those elements and the fire is extinguished.

The trainer then introduces the notions of radiation, convection and conduction. A range of animations are included in this section to provide graphical representation of these principles as well as a short animation which includes a voice-over describing the effects of radiation and why bush fire-fighters should move away from heat sources. Several animations are used to illustrate points in subsequent slides, including a diagram showing the effects of radiation and an animation on a map showing the rapid bushfire spread due to wind. This preceding explanation takes the first 25 minutes of the instruction.

The next part of the instruction introduces the concept of bushfire behaviour, which the trainer introduces, as follows.

So, what is bushfire behaviour? It's basically the characteristics of any given fire and this can include, spotting, rate of spread, flame heights and intensity. It's what you can be looking at when a fire is going.

A four-minute video is used to graphically illustrate spotting, rate of spread, flame height and intensity. The instructor introduces the video and asks trainees to look out for several elements.

The trainer then introduces the terminology of the parts of fire and in this section, he stresses the importance of knowing these terms as this helps with communicating to others.

Fire terminology. This is stuff that you will need to know. It's going to help with your communicating with your supervisors on the fire line and for transferring information to operations officers and other people on the fire-ground. It's important that we are all talking the same language. So, it's important that you remember all these terms, they are all pretty straight forward.

The remaining 20 minutes is dedicated to an explanation of the factors affecting bushfire behaviour. A number of photographs and graphics are used to illustrate the three major factors affecting bushfire. Several simple physical devices are also used to illustrate several critical points. For example, a small wire cradle and newspaper is used to illustrate how fuel shape impacts on fire spread – flat layers of newspaper when lit are harder to ignite and fire spreads across them slowly, while crunched newspaper provides an illustration of quick ignition and fire spread. The trainer uses the blackboard to illustrate other points.

7.1.2 Instructional strategies of the lecture delivery

The trainer appears comfortable with the lecture style of presentation and the delivery is easy and relaxed. At the start of the session the trainer clearly states the purpose of the session and discusses the lesson objectives and draws together some key points at the end.

To enhance the lecture, the trainer provides numerous work-based examples in his explanations, as well as those provided by the video, diagrams and photographs in his '*PowerPoint*' presentation. The trainer generally has the group's attention and invites trainees to ask questions as the presentation progresses (although this only occurs once). The trainer takes a professional and respectful tone when interacting with the trainees.

The session follows the structure that is prescribed in this component of the training package. This structure and the PowerPoint slides can be altered easily to suit the trainers' preferences for sequencing the instruction. Trainers reported that they do in fact alter the sequence, however in the sequence observed this would have happened at the planning stage, as the trainees' notes (containing copies of the PowerPoint slides) needed to synchronize with the instruction as it unfolds.

The instruction starts by describing the fundamentals of fire, moves from the basics of combustion to the forms of heat transfer, and then addresses the nomenclature of the parts of the fire and other terminology. The instruction finishes with an in-depth description of factors that affect bushfire behaviour. The overall structure then reflects the notion of starting with basic science concepts and providing a breadth of basic bushfire behaviour knowledge to follow. The curriculum, then, is organised in a logical sequence leading from the basic to the complex.

Interaction between trainer and trainees was limited to the trainer's questions, addressed to the class at large. In the hour-long session, the trainer asked twelve questions. In order to investigate this interaction further, an analysis of these questions was undertaken and is presented in section 7.3.

7.2 The bushfire simulation-based delivery

The alternate approach used to deliver the bushfire behaviour unit uses a *simulation table*. The *bushfire simulation table* is a portable, steel table that facilitates the demonstration of the effects of fuel, weather and topography on *bushfire behaviour*, the principles of combustion and other understandings critical for bush fire fighters (see Figure 4 below). The table is covered with a flammable hessian which, when set alight, allows the flame to carry across the table. The table surface can be elevated at various sections to provide slopes within the simulated terrain. Other objects can be placed on the table to represent miniature versions of structures (e.g. toy houses, barns), elements of natural landscapes (makeshift miniature trees, lakes and marshes), vehicles, animals or people. These various other *props* can be arranged to represent a landscaped fire-ground in which various scenarios can be played out. Trainees and trainers can move around the table and move the *props*. The activity that transpires on the table is accessible to groups of 10 -15 participants.

Simulated fuels are placed on the table, consisting of leaves, twigs, bark and sticks to provide learning points concerning the effects of fuel on the fire. Both the flammable hessian and other simulated fuels can be set up to model particular *bushfire behaviour* effects (e.g. how fire moves more quickly when the gradient of a slope is increased). The apparatus is generally used outdoors to capitalize on the actual winds to provide wind effects for the scenario the trainer is trying to simulate. The table is on a set of castors which allows easy relocation or change of orientation relative to the prevailing wind on any given day. On windless days, some trainers have used garden leaf blowers to simulate the wind effects.



*Figure 4: The bushfire simulation table*¹⁸

7.2.1 A narrative of the simulation-based delivery

There are two distinct parts in the learning sequence. In the first part is an introductory sequence where the trainer introduces the trainees to the aims of the unit, the key concepts of the science of bushfire behaviour and other related themes. This proceeds in a similar manner to the classroom lecture delivery. The second part of the learning sequence, is where the trainer ignites the fire on the ‘table’ and, as it progresses, involves the trainees in dialogue about what is happening, including some activities which requires trainees to engage with problems as they unfold. The following provides a more detailed commentary of these two parts of the learning sequence.

In the first part of the exercise, the group assembles around the ‘fire-table’ and the trainer provides an introduction to ‘bushfire science’. The duration of this sequence was just over thirty minutes and trainees are required to attend this session in their full bush fire-fighter protective clothing, including their gloves as they will be working close to the fire.

¹⁸ This is a photograph of the basic skeleton of *bushfire simulation table* (including a fire hydrant for safety measures and a large box containing the *smaller props* and *fuels* used with *the table*).

The key themes introduced in this section, align with the learning objectives outlined elsewhere (see Table 15 in Chapter 4). This is essentially a didactic, introductory activity but seeking to involve trainees by frequent questioning. The method of questioning used by the trainer involved asking a question of each trainee in turn which encouraged a greater level of involvement. This method also gives trainees an expectation that they will need to stay alert.

There are a number of demonstrations and activities introduced in this segment including; the two-candle demonstration (this demonstrates how gases released from heated fuel can cause ignition not the fuel itself) and an activity where trainees are asked to calculate the speed of the fire as it moves up a slope. For this last activity, trainees are introduced to a heuristic that helps bush fire-fighters estimate the acceleration of a fire dependent on the angle of a slope and a simple device for estimating slope. The trainer adjusts the slope on the *simulation table* starting from low angle and moving up in gradients and trainees are singled out to use the device to measure the angle and are asked to calculate the speed at which the fire moves at each new angle.

During these activities and the introductory talk the trainer uses the *bushfire table* to illustrate his points. For example, he visually references aspects of the ‘fire-table’ terrain. This helps to familiarise learners with the various components on the table.

In the second part of the learning sequence, the trainer initiates a number of activities which illustrate, reinforce and elaborates on the learning points made in the introductory part. There are five segments which includes exploring the following; bush fire-fighter personal safety (1); the various suppression techniques (2); the range of effects on the bushfire (3), the factors affecting a developing bushfire (4) and further concerns about bush fire-fighter safety and suppression techniques (5). A narrative of each of these activities follows. (The script of this narrative is provided in full in Appendix F).

7.2.1.1 Segment one – Bush fire-fighter personal safety on the fire-ground

In segment one, the trainer starts by issuing a surrogate bush fire-fighter (a small plastic toy soldier) to each member of the group and asks the trainees to locate their ‘bush fire-

fighters' in safe locations on the fire-ground. He introduces the activity by tying the main theme, *bushfire behaviour*, to issues related to safety.

Trainer: I'm going to light a fire from up here [indicating the ignition point on the table], so your knowledge of bushfire behaviour should be directed towards bush fire-fighter safety, which is what it should do anyway (see transcript at 53:50 mins).

As the trainees start to mill around the table there's general discussion amongst them. Some comment on others' choices, causing some laughter between them. Others stand back, watch and then move forward to place their 'bush fire-fighter' on the table. Some look a little confused and tentative about their placement. Some trainees watch the others and choose to place their 'bush fire-fighters' adjacent to those already there. Once they have placed all the toy soldiers the trainees reposition themselves; they move closer to the table, standing abreast to form a full circle around the table. This is unprompted as the trainer is rifling through his equipment at this time. The trainer then moves inside the circle of trainees and moves up and down the table inspecting where all the 'bush fire-fighters' have been placed.

The trainer then proceeds to question trainees individually, or in small groups (if 'bush fire-fighters' are clustered together) and asks each to articulate their reasoning. He points to each 'bush fire-fighter' in turn and directs his questions to the trainees involved, each time starting with the opening question "*what's your theory?*" or "*what's your thinking?*". Each time he positions his body close to where the 'bush fire-fighter' is placed on the table, giving the trainer some scope to point to, and in some cases to touch, physical aspects he wants to illustrate on the table. It also places the trainer in close proximity to the trainee(s) he's talking with (Figure 5, below, represents the typical stance taken).

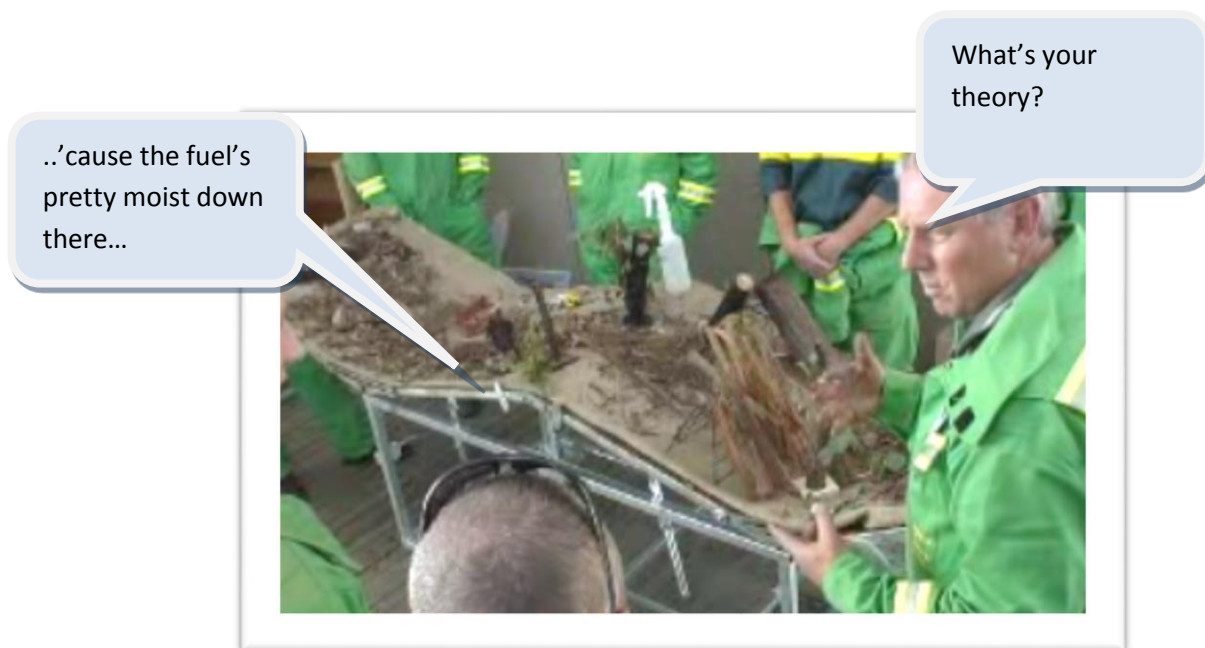


Figure 5: Trainee and trainer discuss the position of the 'bush fire-fighter'

During the observation, as the trainer questions the trainees about their choices, he discovers early that across the group, the trainees are struggling with this first activity. The trainees typically provide a single reason for their choice. Their explanations include the relative safety of wet gullies and the possibility of using physical barriers as protection from radiant heat. In fact, many have taken defensive positions behind buildings or a firebreak. While one trainee mentions that his choice was based on a possible escape route, thus adding additional important information about safety, very few students are able to elaborate further. In contrast, another trainee provides a sophisticated explanation, saying, "*I imagine the fire is moving in this direction* [he moves to the table and makes a hand gesture along the 'imagined' fire-line] *and I will be on the flank*" (56:56 mins), illustrating an 'indirect attack' position. As 'indirect attack' was not mentioned in the introductory session or any sessions previously, this response indicates that the trainee has either previous experience or has conducted pre-reading or study. So, aside from this instance, the general feedback indicates to the trainer that he needs to pitch the activities towards the least experienced trainees, which appear to be most the group.

Nevertheless, the activity has increased the level of involvement of the trainees and the trainer senses the problems early¹⁹. After elaborating a couple of aspects of the ‘bush fire-fighter’ positions, he moves quickly to the next activity. However, he does signal on a couple of occasions that as the fire progresses it will be interesting to see how things play out.

In sum, on the instructional level, the first segment provides opportunities for trainees to relate back to the main concepts introduced in the introductory learning sequence as well as to activate prior knowledge and experience that they may bring to the training.

Although this is an entry-level course, the prior knowledge trainees bring can be varied. In the case in point, it seems that many of the students have quite limited prior knowledge and experience.

7.2.1.2 Segment two - the various suppression techniques

In the second segment, the trainer sets up an activity focused on fire suppression. He issues some trainees with spray bottles (containing water or foam) to simulate various types of suppressant techniques that are used by the agency, including the use of water tankers, helicopter water bombs, slip-ons etc. Each time the trainer allocates one of the simulated suppressant devices, he provides details of the amount of water or chemical foam that each type of equipment can carry. For example, he says: “*Helicopters carry 800 – 1000 litres – so [for example] a small one like Elvis*” (58:53 mins). He then allots the number of ‘squirts’ each suppressant operative can use and allocates a corresponding time. For example: [he speaks directly to the trainee who oversees the ‘helicopter’] “*helicopter support, you get two squirts every minute*” (58.53 mins). The trainer also provides the trainees with the main duties each of these ‘suppressants’ will have when the bushfire is underway. For example, he describes the ‘tanker’s’ role.

¹⁹ I observed two consecutive lessons with the same trainer using the ‘simulation’ approach on this day but with two different groups of trainees. The above observation was on the second session on that day. The trainer later discussed with me that this second group struggled with the ideas introduced earlier in the session. This prompted him to spend more time returning to these core themes as the session progressed.

Trainer: ...the main job [of the tanker] is to protect these houses [points to houses on the 'northern' end of the table]. We'll tell you when we want you to squirt. See some of these houses have done a fairly constructive job of clearing but this one here hasn't so the process of defending their house [points to the less prepared house] might be a bit dodgy (59:45 mins).

In the latter part of this statement, the trainer provides additional observations about the preparedness of the three houses.

Additional ideas introduced in this sequence include how 'Phos-checks'²⁰ are used to stop the combustion process.

Trainer: It's a chemical [phos-chek] the DSE²¹ uses in our helicopters in the form of a bomb – you'll see it in the aircraft session [another unit in the course]. What the phos-chek does is it's a chemical which stops the combustion process, so that no amount of heat we apply to this fuel will make it burn. (60:06 mins)

During this short segment, the trainer thus continues to revisit and further elaborate on ideas introduced earlier. In particular, he further elaborates some of the characteristics of the 'suppressant' vehicles, retardants (etc.) and to ground this information into real world activity and problems. Specifically, the factual knowledge (e.g. the range of suppression equipment, the type of retardants used) and the procedural knowledge (e.g. the techniques used with fire suppression) is interrelated. The focus in this case is similar to the previous case, in that the focus is not simply on the knowledge per se but on how the knowledge relates to activity.

²⁰ Phos-Chek is a brand of fire retardant.

²¹ DSE is short for the Department of Sustainability and Environment which was the Departments name at the time these interviews were conducted.

The trainer also returns to the issue of bush fire-fighter safety, and as alluded to above, introduces the idea that suppression plays an important role in bush fire-fighter safety and asset protection.

Trainer: [indicates to the crews positioned besides the dozer] It's all about protecting the dozer and the crew; it's not about fighting the fire..... it's about safety. (60:02 mins) and

Trainer: The tanker holds about 4,000 litres but you can only work off this road here – the main job is to protect these houses. (59:45 mins)

In doing so, he is also building a profile of practices that are specific to the practices for this agency; for example, as much of their bush fire-fighting may be conducted in areas where road access is limited, and the larger tankers are limited in access to roads only, they are often assigned to asset protection (See e.g. 59:45 mins). On the other hand, slip-ons can be assigned to different roles as they can access more remote areas – e.g. fire suppression, protecting the bulldozer (see 60:02 mins).

7.2.1.3 Segment three - the range of effects on the bushfire

In the third segment, the trainer ignites the fire as a simulated lightning strike and then calls for immediate helicopter attack which fails to extinguish the fire. The trainer then produces another 'lightning strike' in an adjacent area and this time the 'helicopter attack' is successful. Once the second fire is extinguished, the trainer's commentary quickly reverts to the unextinguished fire, now accelerating up-hill, to make observations about a range of aspects, including the use of the *rake-hoe*²², radiant and convective heat, fire-shape, point of origin, escape routes and a question about the wind direction. Additional learning points made in this sequence of events is the value of early intervention to successful fire suppression and the threat of radiant heat to bush fire-fighter safety.

²² The rake-hoe is this agencies primary 'fire-fighting' tool and is used to build defensive breaks on the flanks of fires. It is also used in the 'blacking out' procedures.

When focusing on the ‘first attack’ tasks, a particular orientation to the ‘fire’ is created, for example, the trainer focuses on what has immediately proceeded.

Trainer: See the shape of the fire? It’s almost text-book. [The fire] started at ignition point of origin; backed away from that point of origin which was in here [points to the dead match left here]. It’s going out, influenced by a bit of wind and a bit of slope. (64:25 mins)

At other times the focus turns to what is happening as part of the task, and then switches the focus to what might happen in the future.

Trainer: The water [of the helicopter attack] slowed down the head of the fire but the radiant heat from the rest of the fire evaporates the water and it’s starting to look a bit shaky up here on the retardant line [points to the line at the top of the hill ahead of the fire]. (64:00 mins)

At this stage, two aspects of suppression are explored; the limits of suppression resources and how various suppression activities work in combination.

7.2.1.4 Segment four – examining the factors affecting a developing bushfire

In the fourth segment, the fire accelerates up-hill, progresses towards stacked fuel on a steep slope and then traverses the ridge. As the fire progresses towards stacked fuel on the steep slope the trainer contrasts the challenges posed by ‘line fires’ as opposed to ‘spot fires’ and questions trainees again about the nature of the combustion process. As the fire flares-up in stringy bark fuel, another call is made for ‘tanker’ and ‘helicopter’ attack to save ridge-top houses in the path of the fire. Further water attacks are called in to protect a couple of ‘bush fire-fighters’ but they ‘perish’ from exposure to radiant heat. Trainees observe the fire accelerating up-hill and traversing the ridge, almost destroying a toy house in its path, despite attempts to protect it by “helicopter attack”. As it subsequently burns downhill at a slower pace, the trainer uses this comparative lull to further question the trainees and identify the factors which caused the simulated fatalities. Other personnel are protected by water bombing and some are removed to the flanks.

The main point made at the start of this sequence is that heat induces the release of gases from fuel which ignites to accelerate the fire - returning to the concept of the combustion process. He introduces a configuration of fire – a ‘line fire’ - moving along a wide front using a long piece of flammable string to create the effect and as the ‘fire’ spreads along the wider front, demonstrates how a fire can grow exponentially.

Before taking these actions, the trainer asks the trainees to speculate on what might happen when the ‘fire’ hits the ‘string’ and begins to broaden. Again, he coaches and guides the students, as follows.

Trainer: [directs the question at a particular student] What would be the difference if we had a line fire? Where the fire has had a chance to develop and there's nothing to impede it.....

Trainee: It'd be going faster?

Trainer: Why?

Trainer: There'd be more heat.

Trainer: And what is that heat doing? It's heating the fuel, releasing the gases. So the more fire we have, the bigger the fire will get, so I'll show you. (66:32 mins)

In this segment the focus returns to an idea introduced in the previous segment - the dynamics and shape of a developing bushfire -and a concrete demonstration is provided. This reinforces the understanding that heated fuel releases gases which burn to release more heat to make a bigger fire. As the larger fire develops, the trainer again models expert observation and questions trainees in order to draw upon their growing awareness of the need to read situational cues. He returns to key objectives and by building on previous objectives expands on these ideas; including the effects of combustion in

different fuels, the effects of different types of heat, the different types of fires and the inter-related effects of fuel arrangement, topography and wind direction.

7.2.1.5 Segment five – further concerns about safety and suppression techniques

The final sequence of the exercise, as the fire advances up the final slope towards a settlement on the last ridge, is devoted to techniques of suppression, regarding mineral breaks and the application of water and foam retardant.

The trainer begins this sequence with a review of which “bush fire-fighters” have survived to date, which ones have died and whether any of the remaining personnel will need to be relocated, referring once more to fuel type and arrangement, topography and flame height.

Trainer: These one's over here [did not survive] ...a bigger fuel hazard and the fuel type was totally different...and the flame height of that [stringy bark] caused the problem (73:06 mins).

He indicates two bush fire-fighters sheltering behind a large log and calls for helicopter support.

Trainer: What we don't want is for the fire to start burning under there. We want to keep him away from direct flame – no one is stupid enough to stay in direct flame. If we got a helicopter in now there'd be a fair chance of saving him, so, helicopter, get in there (76:05 mins).

Indicating two other bush fire-fighters located in a cattle yard, the trainer sees them as threatened.

Trainer: These people here, with fire backing down the hill are threatened but they've got scope to move out of the way, so we'll just do that (77:05 mins).

The trainer then turns to the theme of suppression techniques having previously indicated that these will be dealt with more thoroughly in subsequent training exercises. He first indicates the importance of not wasting water, as follows.

Trainer: I know we haven't done suppression but we try to put our water along the edge – there's no real point in putting water in there. Try to put it along the edge of the fire – that way we get the best bang for our buck. (78:30 mins)

He points out that, as well as the safety of personnel, a high priority is placed upon protection of the bush fire-fighting equipment and other assets. He instructs a trainee to use his tanker to this end.

Trainer: Ok, you've got to protect all the assets here.

He calls for a 'foam operator' to reinforce a discontinuity in a mineral break.

Trainer: We're going to have the biggest problem here. We haven't got a continuous break so see if you can lay a foam layer across here to control it, as quick as you can. (79:03 mins)

At this stage the fire has reached the end of the table, terminating at the mineral/foam break established below the ridge-top settlement. The "suppression crew" proceeds to extinguish the remaining flames. The trainer sums up the exercise with a positive note.

Trainer: Ok any questions? It's not high brain stuff picturing what's going to happen in the landscape, what the bushfire behaviour is going to be like. Know where the topography is, put yourself somewhere safe and it works. It's not complicated, being in the right spot where the radiant heat is not going to get you. Is everyone around that? (83:40 mins)

7.3 Comparing the levels of cognitive engagement in the two examples of the enacted curriculum

An analysis of the questions asked in these two observed lessons was undertaken and this has provided some more insights into the level of engagement that was expected of trainees and the level of cognitive demands that are expected through these interchanges. This analysis was undertaken by using *Bloom's taxonomy of cognitive domains (1956)*; Figure 6 below represents the resulting profile of the questions posed during the lecture delivery. It was found in the lecture-based approach 12 questions were asked. Of these, 9 were knowledge-based questions, where trainees were being asked to recall something covered previously, and 3 were slightly higher-order questions requiring some comprehension of the combustion process.

On the other hand, in the simulation-based delivery, 61 questions were posed by the trainer leading this session. Most of these questions sought to reveal the extent to which the various concepts and information had been understood. Some questions required higher order thinking, as illustrated in Figure 7 below. Therefore, it can be concluded that when compared to the standard approach used to teach *bushfire behaviour*, in the simulation-based delivery that the pattern of interaction between trainer and learner is more intensive. It can also be concluded that students are expected to interact at a higher level of thinking.

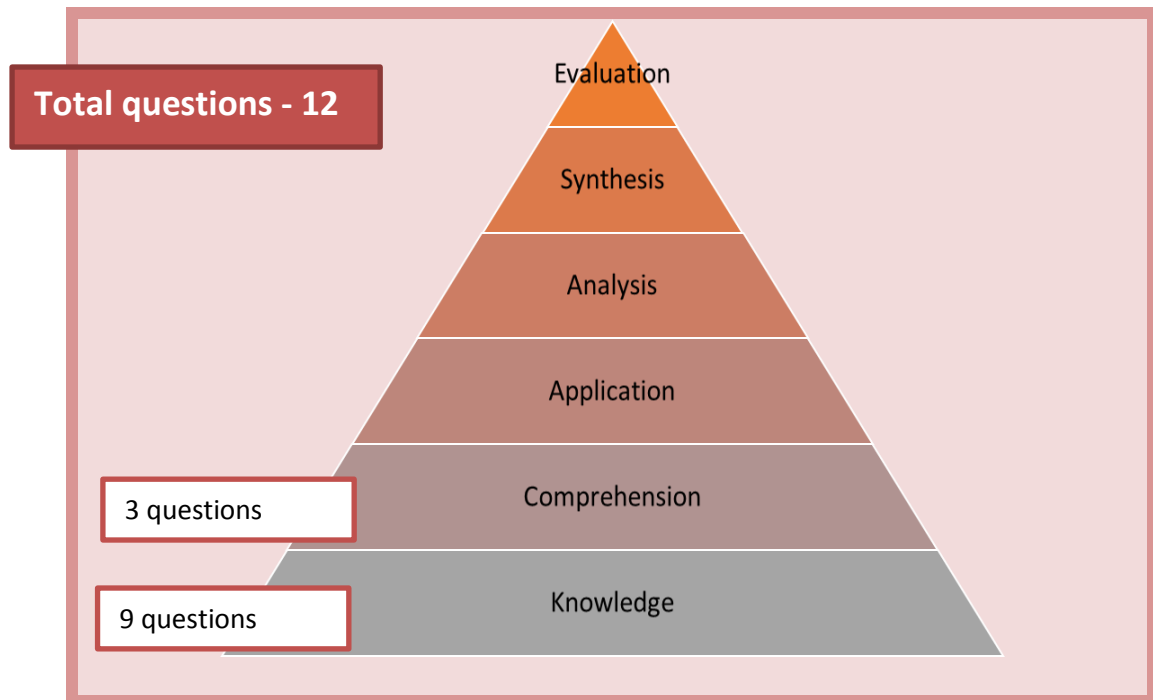


Figure 6: Questions asked in the lecture-based learning sequence on bush fire-fighting and their congruence with Bloom's Taxonomy

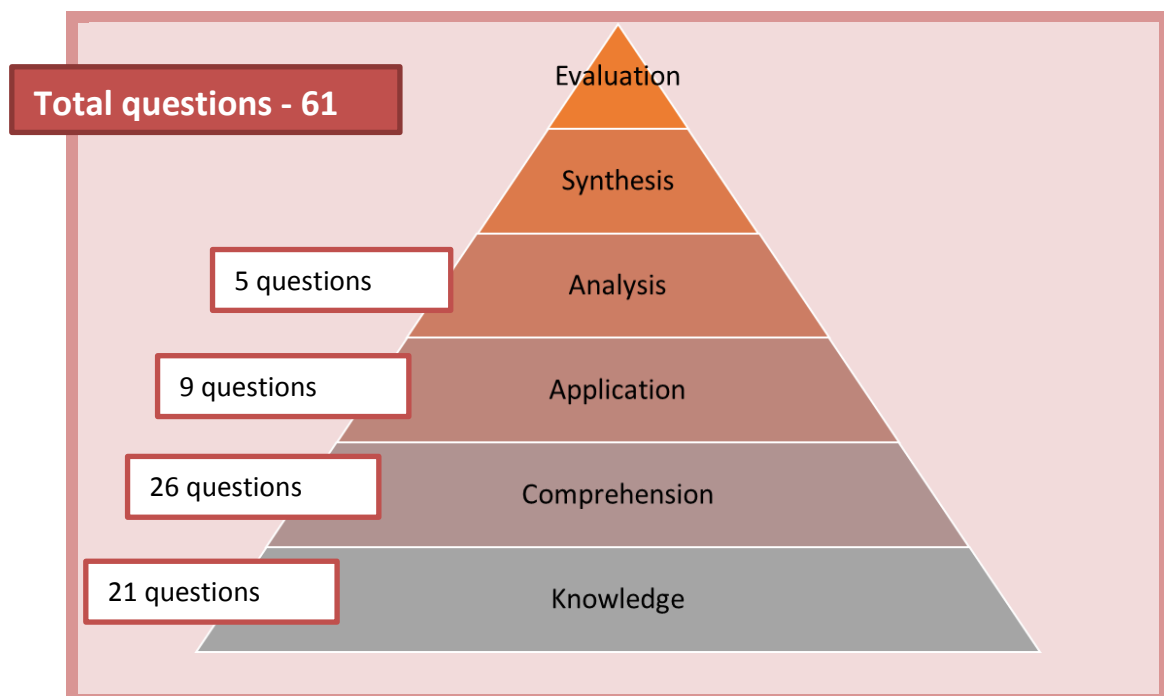


Figure 7: Questions asked in the simulation learning sequence on bush fire-fighting and their congruence with Bloom's Taxonomy

7.4 Conclusion

The aim of this chapter was to examine the way educational strategies are employed to teach *bushfire behaviour*, including the way the concepts of bushfire behaviour are communicated to trainees. It asked; How is the teaching of the science of bushfire behaviour currently enacted in the learning environment? (Research question 4) The chapter examined two approaches to teaching the standard unit on bushfire behaviour; the first was the traditional lecture delivery which is the standard approach used in this training course. The second was a simulation-based activity that was being used to teach this unit for the first time.

Observations and analysis of these contrasting approaches revealed several findings. The lecture approach uses a teaching-centred approach with minimal interaction between the learner and the teacher and the second uses a much more learner-centred approach. An analysis of the questions asked during these sessions reinforced these findings, both in terms of the number of interactions initiated by the trainers and the quality of the questions asked. On the first, although the sessions were approximately the same length, in the traditional lecture delivery the trainer asked 12 questions in contrast to 61 questions that were posed in the simulation-based lesson.

On the second, it was found that 9 of the questions asked in the traditional approach were knowledge-based questions, asking learners to recall something covered previously, and 3 were slightly higher-order questions requiring some comprehension of the combustion process. In contrast, of the 61 questions posed to learners in the simulation session, most of these sought to reveal the extent to which the various concepts and information had been understood (40 questions in total).

It is contended that when compared to the traditional approach used to deliver this part of the curriculum, the simulation-based activity is much more immersive and when coupled with skilled questioning by the trainer has the potential to engage trainees at a higher level of comprehension. This approach engaged trainees more actively by having them make choices about strategy, with responsibility for the consequences of their decisions. The

session not only conveyed the concepts of fire-science but embedded them within the practice of bush fire-fighting. Given the difference in this approach, how and why it works will be further investigated in the following chapter.

Chapter 8

Examining the affordances and outcomes of the simulation-based activity

In the previous chapter, an examination of the delivery of the *bushfire behaviour* component using the traditional lecture-based approach and the alternative simulation-based approach suggested that in the latter case learners are expected to engage at higher cognitive levels and that the pattern of interaction between trainer and learner is more intensive, as well as providing affordances of situating the theoretical concepts of bushfire behaviour within the practice of bush fire-fighting. This chapter presents the results of a second and closer examination of the simulation approach in order to focus on what can be understood about the ways in which it addresses the challenge of providing learners with an understanding of *bushfire behaviour*. The chapter addresses the following research question (5); What are the affordances of a situated immersive pedagogy in teaching the science of bushfire behaviour?

Answers to this question will help to develop a model of this pedagogical engagement for application on a broader scale.

First, the results of the analysis of the core elements of this simulation-based approach are presented (section 1). The significance of these findings are considered, with discussion of the learning that underpins this pedagogy, the knowledge it generates and the core modes in which it operates (section 2).

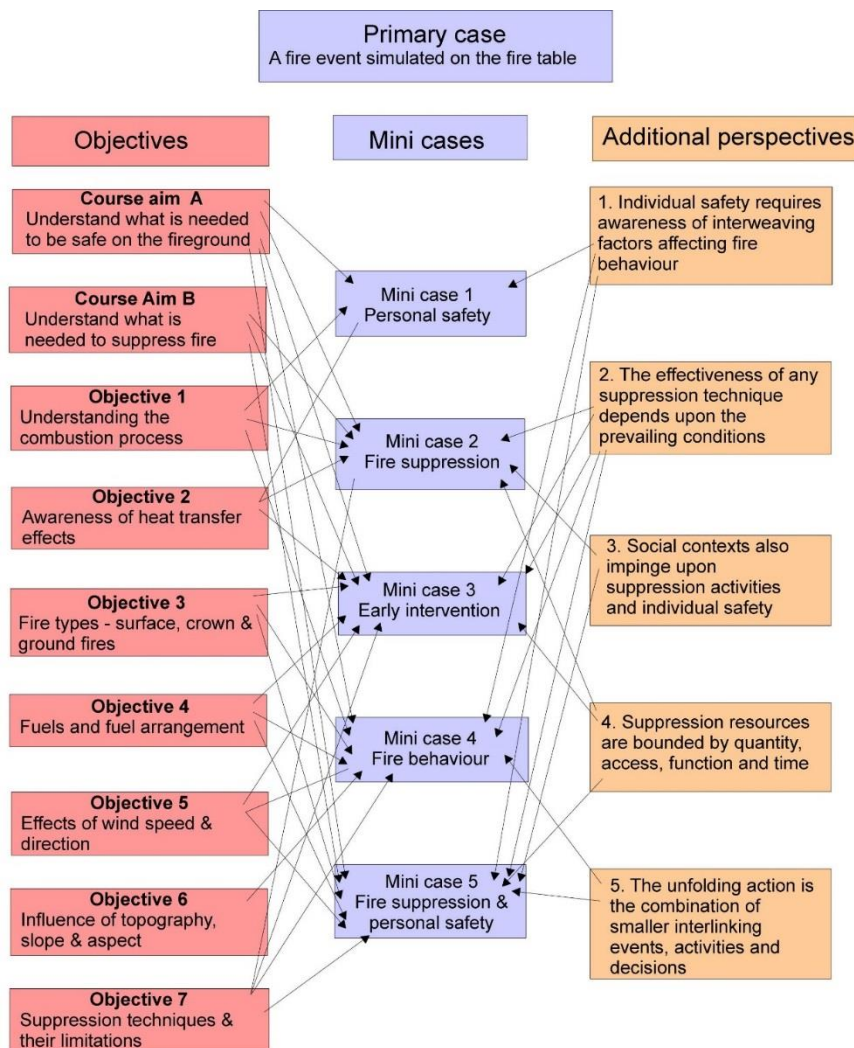


Figure 8: The interconnectedness of the case objectives

The previous chapter provided a narrative of the observed simulation-based delivery, which consisted of a main event, a fire moving across the simulated landscape (referred to in Figure 8 as “the case”) and five smaller episodes in the sequence of events (referred to in the diagram as “mini-cases” and in the following text as “segments”). The mini-cases comprised a range of activities which addressed the principal learning objectives and also served to introduce some additional perspectives relating to the practices of bush fire-fighting. A mapping of these demonstrated that case objectives and perspectives were accessed as the learning sequence progressed, and revealed an array of interconnectedness

of these core ideas, as shown in Figure 8 (above) (Table 18 below outlines the five episodes that occurred during the observed learning sequence).

Table 18: The five episodes occurring during the observed learning sequence

MINI CASE	MAIN ACTIVITY (or mini-cases)
One	Bush fire-fighter personal safety on the fire-ground
Two	Examining the various suppression techniques
Three	Exploring the range of effects on the bushfire
Four	Examining the factors affecting a developing bushfire
Five	Exploring further concerns about safety and suppression techniques

8.1 Examining the core elements of the emerging pedagogy

The analysis identified three core components to the pedagogy. The first concerns the scope of the content covered and how this knowledge is being represented. The second considers the interactions that are established between trainer and trainees and types of “meaning” negotiations that are included. The third concerns the nature of the activities that are undertaken and how these are afforded. This provides insights into the learning environment established. The section ends by drawing together these various components to highlight the significance of the findings.

8.1.1 The contents and knowledge representation

The narrative shows that each exercise on the “*fire-table*” simulates a case of fire in the landscape, used to illustrate the science of bushfire behaviour and relevant aspects of bush fire-fighting. Five segments of the sequence can be identified, each containing elements that reflect the aims and objectives of the curriculum. It is evident that an extensive

amount of the content of the *bushfire behaviour unit* curriculum is covered, to include the main objectives of the unit (See Figure 8, above).

The first aspect to note is that during each segment, learners are encouraged to engage with several concepts. The learning experiences provided by the sequence of segments or episodes in the *fire-table* exercise are a means of further consolidating the trainee's knowledge base. Aspects of the combustion process (Objective 1) are highlighted in segments 1, 2, 3 and 4, while wind speed and direction (Objective 5) are pertinent in segments 3, 4 and 5, and so on, as indicated by the crisscrossing of lines on the model. Some objectives re-occur less frequently because some segments are relatively small components of the overall sequence.

Secondly, the interconnectedness of the pedagogical objectives is emphasized. In the *fire-table* exercise this is best illustrated by the recurring observations of the progress of the fire up and down sloping terrain in relation to the prevailing wind direction (see segments 1 – 5). In these contexts, learners are directed to observe how conditions vary according to the nature of the topography, fuel, disposition of resources and fluctuation in natural wind conditions during the exercise. This allows engagement with the complex interactions among the key concepts; for example, how the combustion process and the various environmental factors interrelate to affect bushfire behaviour.

In addition to engagement with these core objectives, several additional themes are apparent, which relate to the practice of bush fire-fighting. The analysis identified five of these, which are listed in the right-hand column of Figure 8 (above). As demonstrated in the narrative, they are revisited as the lesson progresses and links between these themes and the various segments are also illustrated in the above figure. These perspectives are not explicitly stated in the curriculum and they arise during activities as the learning experience progresses. In general, they serve to furnish new frames of reference from which to view the activities as they unfold. Whilst some aspects of the pedagogical intentions are explicitly stated, (e.g. when the trainer describes the functionality of the various suppression techniques) others are implied and arise because of the particular focus at different times.

The simulation device functions to replicate the physical aspects of bushfires and associated terrain and conditions, while the fire provides an added dynamic to the proceedings. In this way, novices are lead to focus on aspects of the unfolding situation and to consider the physical situation in the light of various understandings about bushfire behaviour. Specifically, it is the clues and cues provided by the physical setting and direct guidance that provides the key representational focus. The knowledge is strengthened by visible observation of the effects discussed and by questioning and scaffolding from the trainer.

The analysis indicates that two instructional processes are at work. Demonstrations of the fundamental properties and the physical processes of combustion (i.e. the fire triangle), are linked to other concepts and information within the conceptual framework (e.g. suppression techniques) and these are demonstrated within each episode. The episodic nature of the cases also supports an *overlapping approach*, providing links from the related concepts within a specific context with important themes (e.g. safety considerations). These themes recur across the various segments, allowing different facets to be highlighted.

In sum, the approach provides learners with a set of lessons about how some specific conceptual themes are instantiated in a particular context (Gott, 1989). These are represented via a range of episodes (segments) where learners are being asked to reflect on the concepts of “fire science” within and across various contexts. In this way, the applied and episodic nature of the *fire science* skill is highlighted, providing an extensive coverage of the basics of bushfire knowledge and skills as they are embedded in practice. Whilst the knowledge is represented in this way, a closer examination of the interactions and negotiations that occur demonstrates a model of immersive pedagogy.

8.1.2 Core interactions and negotiations

On the level of interactivity, keen attention is given to current and ongoing action, seeking to embed several skill-based behaviours but particularly to stimulate *noticing* behaviours, which manifest in three ways. The first is a focus on *what to notice* within the situation.

So, when novices notice only one aspect, they are prompted to attend to other aspects, or when they preface only a minor aspect they are redirected to attend to more significant aspects that might be manifesting in the physical setting.

The second aspect concerns drawing attention to *noticing* the finer aspects in the situation that presents. This is apparent in the first part of the lesson when the learners are asked to speculate about the various influences that might prevail and encouraged to appraise their “sheltered” situations more closely. However, once the ‘fire’ is started, this focus is not sustained as there is a tension between focusing on detail and a desire to monitor the overall flow of the activity.

The third aspect, is that the *noticing* skill is exercised as a matter of course; its exercise is not dependent on the nature of the experience. Whether it’s a small or complex situation, the focus is on the *need-to-notice* in the first place, and in this way, it is presented as a routine skill. The three components taken together demonstrate that there is an emphasis on enriching the *noticing* behaviour, seeking to strengthen the *need-to-notice* skill, the need to focus on the various aspects that might be presenting including the finer aspects.

On one level of negotiating meaning, the above could be interpreted as the trainer wanting trainees to build an appreciation that *all* fire events have the potential to “get out of hand” and should be treated with due caution and attention. Alternatively, this interaction might simply reflect the trainer’s desire to use each event as a learning point and, by engaging these *noticing* behaviours, create the scope to stimulate discussion and interest in the specifics of the events. However, the negotiations that centre on *noticing* coincide with explaining or elaborating conceptual connections and the two aspects work in conjunction.

Another aspect of negotiating meaning is the pattern of interactions that are established and the kind of support provided. The pattern of interactions during the *fire-table* exercise can be characterised as a dialogue between trainer and trainees, in which trainees are encouraged to participate in the purpose of mutually building an understanding of what is happening as the fire runs its course.

Although the trainer's theoretical introduction is essentially didactic it employs a conversational approach which fosters in the trainees a sense of participation, such that when the action is to be commenced they gather around the *table*, unbidden, to stand shoulder to shoulder with the trainer. The trainer formalizes an expectation of participation by his allocation of toy-soldier "bush fire-fighters" and the requirement to place them in safe locations, thereby committing them to making decisions for which they may be later accountable. His subsequent questioning of each individual - "What's your thinking?" - heightens the perception of mutual involvement in the event about to unfold. The assignment of suppression roles to trainees (helicopter, water tanker, etc.) further enhances the expectation of participation and, to some extent, accountability. Throughout the exercise, frequent questioning is used by the trainer to sustain the level of participation, in addition to its didactic purposes.

Within this overall mutuality of participation, the level of guidance and direction from the trainer is very important and asymmetric to the limited knowledge of the trainees. Nevertheless, there is scope for participants to have some level of agency - they are involved in decisions and in some instances, they feel free to propose actions. At the start, one novice volunteers how he might position himself and his crew to engage with the fire and later another sees a need to defend some farm assets and seeks permission to bring in a helicopter water drop.

The participatory exercise thus represents a complex social organisation and relationship to information, in which novices are invited to participate in the activities and skills of bush fire-fighting practice, albeit in a simulated environment. In a sense, they are not being asked just to think like bush fire-fighters but to *be* bush fire-fighters.

To support the learning, various techniques are used to scaffold, articulate and extend the learning. Early in the learning sequence the learners are directed to consider a series of alternatives regarding the safety of their 'bush fire-fighters' physical circumstances. At this stage the trainer can make explicit which of these alternative is most appropriate or guide learners to consider additional aspects. In this case, after suggesting some possible

factors, the trainer opts to allow the direct feedback of subsequent events to reveal the wisdom or otherwise of the trainees' decisions before articulating the issues involved.

Communication is continuous throughout the exercise as the trainer articulates observations and scaffolds the information and theory needed to understand the fire's behaviour, seeking responses from the trainees and embedding the theoretical concepts underlying the events taking place. In these interchanges and in later ones, the questioning also serves to push the learner to articulate as much as possible about the unfolding situation or what they might be understanding about what is happening or what might happen. This types of questioning pushes learners to articulate the scope of their propositional understandings and serves to give the trainer feedback as to level of understanding and how to proceed and adjust on an ongoing basis.

This latter strategy is used judiciously, as the level of confidence of the group is gauged in relation to the degree of participation, the confidence of individual novices and to what extent they can articulate what they understand. The tension is to extend the experience such that it challenges the learners but does not take them too far out of their comfort zone.

8.1.3 Core activities and their affordances

An additional teaching strategy was identified that serves to introduce learners to patterns of behaviour which underpin critical aspects of the skill to-be-learned. There are two strategies used to focus learners on perceptual/cognitive skills and practical problem-solving. The first is the way in which the simulation medium affords a particular activity and the second, closely related, is the relationship created towards problems and actions. This suggests additional qualities to the knowledge and skills which underpin this skill base and the nature of *expert models* required to elaborate the skill.

As shown previously, the simulation device (or medium) allows for the physical demonstration of aspects of bushfire behaviour. However, also apparent are other aspects of the use of the 'medium' that add to its functionality. First, it provides scope for demonstrating a series of interlinking 'fire' events, which means that a more complex

pattern of social, physical and temporal cues can be included. One aspect of this is that the context provides scope for the depiction of situations that are similar but subtly different, prompting the exercise of *noticing* skills. Klein & Hoffman (1992) classify this as a perceptual/cognitive skill, noting that experts see more in a setting than a novice by noticing cues that a novice does not. Detailed observation is an essential component of bush fire-fighter expertise and the *fire-table* exercise provides scope for this skill to be modelled. Another facet of the expertise modelled in this setting is that novices have access to the trainer's responses to situations as they evolve in contexts comparable to situations they will encounter during future deployment (Anderson, 1993).

The facility afforded by the medium to depict a series of interlinking events better aligns with the type of decision making required in complex work environments. In such environments decisions are rarely one action (assessment and then decision) but rather a series of interlinking assessments, decisions and actions (Omodei & Wearing, 1995).

Secondly, the media enables 'interactive' activity in that individuals can respond or act-upon events. In this way, it is also generative in that the actors can affect changes in proceedings. There are times when they can also see the ramifications of earlier actions. Both these facets afford a much more direct access to the environments and experiences of bush fire-fighters.

Thirdly, observing both the processes and solutions that is afforded by the immersive exercise, provides access to different aspects of problem-solving behaviours (Brown, Collins & Duguid 1989). Notably, novices learn that problems continually evolve, that the practical problem of understanding the situation, the demands of the task environment and the actions required are all closely and dynamically linked (Gott, 1989; Anderson, 1993). The rapid movement of the simulated fire heightens the importance of the dynamics of the situation to hand and the moment to moment decision making that is needed. In this way, every moment is new, in a decision setting where multiple decisions may be required because initial solutions may be only temporarily effective as a new situation arises. This again provides scope for modelling of a trainer's adaptable behaviour (Salas & Cannon-Bowers, 2000).

Beckett and Hager (2000) describe this type of decision making as the exercise of “hot action” decisions. These are typically practical judgments that are embedded in day to day activity, decisions about ‘what to do next’ and what is contextually suitable. Similarly, Barton and Sutcliffe (2009) describe this as *sensemaking* which arises from “from action and interpretation rather than from evaluation and choice”. Sensemaking, in this view, is directed at questions like, “ ‘What’s the story here?’ and ‘Now what should we do?’ ” (p. 1331).

It should be noted that there is a degree of criticality to some of these decisions and novices are reminded that they should constantly assess their personal safety in the changing setting and decide whether they should stay or leave. During the exercise observed conditions changed rapidly on several occasions and the novices were reminded of this and given close guidance.

The fourth aspect to be noted is a strategy that is used to shift the trainee’s attention between different levels of context. Novices are provided with the opportunity to observe the behaviour of the simulated bushfire as a complete entity, in contrast to what they would see when deployed at ground level on a rake-hoe line in a practical exercise. This can be expected to allow novices to form better appreciation of bushfire behaviour concepts as they witness the fire’s movement across the simulated landscape. Whilst the action is mostly focused at the active part of the fire, attention is directed towards other dimensions and attention can be drawn from specific ‘fire’ events to the wider context within which the events are operating. This contextual information provides points of reference to link ideas between simpler situational patterns and wider networks of meaning (Weick, 1995, p. 50). The implication of using these types of learning processes are further examined in the following chapter.

8.2 Significance of findings and discussion

The significance of these results are threefold. First that the development of knowledge of fire science and knowledge of the situated requirements for practice are closely tied. These are sourced and formed through engagement in the (simulated) practice. Secondly,

the way the interaction and activities are afforded and the type of negotiations required contribute to the nature of the meaning-making activities. Thirdly, accessing both the processes and solutions that might arise provides closer access to problem-solving behaviours. Critically, it is shown that novices need access to expert performance if they are to build on their own practice.

Taken together, this enabled a focus on the construction of dynamic and functional representations (applied learning), scope to generate new knowledge (adaptable thinking) and access to social and cognitive patterns that permits the conceptualisation and categorisation of problems.

It has been shown that the immersive pedagogical approach requires a deliberate process of integrating practical work-based knowledge with the underpinning conceptual knowledge. This embedded approach entails opportunities to engage learners in pertinent goal-directed activity and to access a range of knowledges and skills. At its heart is a constructive approach to learning which can be understood as enabling active and social learning processes, where the learner draws meaning from the experience and from the guidance of expert others. Especially, it is shown that the immediacy of the learning context provides an important source of the meaning-making that is generated through the experience. This accords with an attitude expressed by many trainers of bush fire-fighters that “real learning”, or meaning-making, derives from live experience on the fire-ground.

In addition to developing the underpinning theoretical learning, this is an embedded approach which engages learners in pertinent goal-directed activity (problem-solving) and these activities replicate everyday contexts and problems. As it is held that both the problems and their solutions are socially determined (Brown et al, 1989), and that goal-directed activity promotes the psychological function of the learner (Leontyev, 1981; Scribner & Beach, 1993), it is proposed that these replicated activities can play a central role in their appropriation (Billett, 1998). That is, as individuals engage in goal-directed activities, they can access, manipulate and transform cognitive structures which are socially sourced resulting in the construction and organisation of knowledge (Billett and Smith, 2014).

As Billett advises, it is Leontyev (1981) that makes this theoretically important move towards incorporating *activity* as an essential component of the social system (Billett, 1998). Leontyev (1977) observed that in modern forms of work, both the internal and external components of activity are becoming increasingly intertwined; he proposes the following: “[The] physical work [of] accomplishing a practical transformation of material objects, [is] ever more “intellectualized, incorporates into itself the carrying out of more complex mental acts.” (p.97). Consequently, in the case in point, an otherwise skill-based vocation is operating in a more cognitively complex task environment, making activity, in some senses, in and of itself the source of the knowledge work.

For bush fire-fighters, this includes understanding the science that underpins the knowledge associated with *bushfire behaviour* as well as understanding how to apply this knowledge. As this work becomes more complex, being able to utilize this knowledge and to be accurate in diagnosing their surroundings is a critical aspect of bush fire-fighter practice.

8.3 Conclusion

This chapter addressed the research question: What are the affordances of a situated immersive pedagogy in teaching the science of bushfire behaviour? (Research question 5)

The analysis revealed three key findings in relation to the learning outcomes that the bushfire simulation approach affords when compared to the traditional classroom delivery of the curriculum. First, it generates different types of knowledge, secondly it affords access to rich associations amongst these knowledges and, thirdly, it engenders understandings about the instance of practice, what constitutes performance within it and how to effectively engage in practice.

Regarding the first, it was found that learners are enabled to access three types of knowledge, including the theoretical knowledge, specific representations of these concepts and operational knowledge. Therefore, in addition to the explicit reference to the key fire science concepts, learners can experience how these elements act dynamically

and how they function within the environment. In turn, they experience how these concepts manifest in different operational contexts.

The second finding, which closely relates to the first, is that access is afforded to rich associations amongst these knowledges. Learners are encouraged to relate fire science to personal safety issues; to consider how environmental conditions interrelate with suppression techniques; to deliberate about the range of suppression techniques and how this affects operations at various levels. However, the intent is the illustration and articulation of the critical fire science variables and the exploration of meaning associations among them.

The third finding is how the learning context engenders understandings about performances. There are three key aspects that the analysis revealed. First, it is shown that entry-level bush fire-fighters are taught about how to perform in the field. They learn about the need to observe and read the context, how the suppression techniques they use affect fire and what crews do on the fire-ground. Second, the characteristics of performance are brought into focus for the learners; for example, they learn about “noticing” behaviours and how the bounded nature of suppression techniques impinges on the capacity for crews to act.

However, they are not simply guided in performance-premised tasks. The third aspect is that they are introduced to a set of expectations about how they *ought to perform* in this work role. For example, they learn about practical task-responsibility, that ‘noticing’ is an important and ongoing responsibility; that ‘noticing’ is a shared responsibility and that open communication can contribute to a group’s overall level of awareness and thus safety.

A major implication of this immersive pedagogical approach, in which there is a higher degree of trainee participation, is the opportunity it affords for trainers to conduct formative processes of assessment, leading to a better reflection of the curriculum goals and how well they are meeting their goals. While providing novices with access to expert knowledge and guidance, the learner-centered environment in which trainees were

expected to voice their perceptions represents encouragement for them to develop perceptual and analytical skills from an early stage of their training. This represents a pedagogic, perhaps even cultural shift in the pursuit of a more conceptual-based bush fire-fighter performance.

The implication of these, and other findings in this thesis, are examined in the following and final chapter.

Chapter 9

Conclusions and implications

This thesis has investigated how bush fire-fighters are being educated to gain entry-level knowledge in the face of changing practice demands and to understand the role that curriculum and pedagogies play in the building of capacity to meet these demands. It is contended that in order to meet the challenges posed by the increased threats of bushfire, a broadening and deepening of the entry-level knowledge base is required of fire-fighters and a more intensive effort to prepare novices for operating effectively and safely during transition into their working roles. These concerns present critical educational challenges for this workforce, with implications not only for the safety of individual bush fire-fighters but also for the viability of the broader emergency response and its ongoing mission to protect communities.

To these ends this thesis has examined how the curriculum and training for bush fire-fighting has been organized and the challenges posed by changing demands. It has probed the perceptions of learners and trainers about learning bush fire-fighting and examined how the training is enacted in the learning environment.

There are three sections in this final chapter. The following section provides a synthesis of the findings presented in this thesis (section 1). This is followed by a section that draws these findings together by providing an analysis and synthesis of the possible implications and contributions of these findings (section 2). This includes an examination of the practical, theoretical and research challenges and implications. The third section identifies areas for future research (section 3).

9.1 Synthesis of findings

In Australia, having well equipped and highly competent bush fire-fighters is becoming increasingly important as the impact of climate change provides more fuel for fires, as

mentioned in Chapter 1. Fire is an inherent part of the Australian landscape. On the one hand, fire is needed, at times, to assist in various ecologies and, on the other hand, fire also has devastating effects on the environment (e.g., the Black Saturday fires). Major governmental enquiries have identified the importance of training to equip a larger contingent of bush fire-fighters to meet these challenges and the conduct of entry-level training is the focus of this thesis.

Chapter 2 considered the contribution of constructivist learning theory, indicating the value of knowledge acquired by cognitive understanding of underlying principles and pointing to the value of teaching for understanding and the importance of problem solving in this process. However, the chapter also considered theories of situated learning and indicated several studies which showed that for novices, early work-based experiences coupled with good mentor supervision is decisive for instilling workplace practice and working methods (Sommer and Nja, 2011, Taber et al, 2008). These studies and other studies (Slade, 2013; Taber, Plumb and Jolemore, 2008; Lloyd & Somerville, 2006; Billett, 2008) also emphasize the importance of the sequencing of activities for novices, to move novice fire-fighters incrementally from peripheral to full participation, from simple tasks to more complex task which require more accountability as their expertise develops (Lave, 1991). Review of the literature on expertise concluded that expertise is derived from a combination of theoretical understanding with wide-ranging practical experience over time, enabling the accumulation of mental simulations and schema to assist decision making.

Chapter 3 outlined the design and methods used to undertake the study, a single case study analysed in the main through interpreted, qualitative methods. Possible limitations regarding the generalization of the findings were noted but it was concluded that the findings are broadly transferable to analogous training environments.

Chapter 4 addressed research question 1: How are the learning goals for entry-level bush fire-fighting currently organized in the curriculum and what are the challenges in delivering this curriculum? It examined the curriculum context for entry-level bush fire-fighters, showing that the key goals of the national Fire and Emergency Service's

accredited training system corresponds with this industry's core responsibility. This includes the protection of public safety and workplace safety as a major focus for the structure of the specified fire-fighter competencies. This is critical because the environment in which bush fire-fighters work is dynamic and ever-changing. Because the workplace for entry-level bush fire-fighters is the fire-ground – a place that is inherently unsafe - the tasks to meet the demands of this workplace are cognitively and physically challenging.

As the discussion and analysis showed, there is an intention to meet the learning needs of bush fire-fighters via a standardised training package which seeks to ensure uniformity of training, consistent with national standards of competency across the industry. This is reflected in the bush fire-fighter *training package*, which identifies the practical competencies specified for the training and the theoretical understandings of fire science and the behaviour of bushfires required to underpin the practice. Given the importance of these understandings, the stated curriculum goals for this theoretical unit of training was examined in more detail.

It was found that the pre-specified knowledge outcomes of the bushfire behaviour component of the curriculum consisted essentially of the ability to recall various schematics such as the “fire triangle” and it is argued that this recall-level of knowledge is not sufficient to achieve the theoretical underpinning intended in the stated curriculum.

In addition to the above findings, a number of challenges in delivering this curriculum were identified. Trainers need to grapple with a content-heavy curriculum whose volume arises from a bureaucratic concern to “tell” trainees everything they must know. This leads to a cumbersome and time-consuming assessment process that is highly bureaucratized. As there is constant external pressure to change or add elements of this content, trainers face a continuous battle to keep the curriculum up to date. These changes can range from institutional policy changes to changing safety practices as a result of governmental and coronial inquiries. Trainers describe the process of responding to these changes as a sort of trainer “battle fatigue”.

The chapter discussed how the curriculum is standardized in the form of the training package to ensure that the “message” is consistent across regions, as well as providing some assurance of uniform training delivery (see chapters 4 & 6). However, whilst everyone is given the same message, it could be argued that this tends to make trainers, via the teacher notes or the dot points on the screen, mere mouth-pieces for conveyance of the curriculum content to the heads of the learners. This can result in the tendency observed by trainees for presenters to mechanically read off the dot points, a monotonous, deadening process which alienates the trainees and inhibits the learning.

All of this is exacerbated by an additional range of commitments the trainers have to fulfil, which include annual audits of training, meeting quality assurance goals and maintaining administrative records and compliance documentation. The analysis shows that a number of challenges arise from the need to superimpose these considerable organisational and bureaucratic functions upon the trainers’ on-going roles as bush fire-fighters and trainers. There is also a top-down push on curriculum, so much so that curriculum reviews are about reacting to these changes, leaving little time for real reform or renewal.

In other words, trainers faced with the demand to cover all that is officially laid down in the curriculum have little opportunity to consider what learning may be taking place or what pedagogical innovation may be desirable.

It was also found that the curriculum imposes demands upon trainers beyond the traditional concept of the role of master craftsman. Trainers now require capabilities to encompass both the world of their industry and an understanding of educational pedagogy. Keeping pace with economic and social changes requires trainers to have a sophisticated appreciation of pedagogical choices available and the ability to adapt and change their curriculum and practices.

Against this backdrop, two conclusions from the analysis can be drawn. First it can be concluded that there is a clear intention to satisfy the need to provide instruction and information via a standardised training package, which seeks to ensure a uniform training

consistent with national standards of competency across the industry. This is important as the curriculum reflects critical components needed for bush fire-fighters to operate effectively and safely.

However, a second conclusion is that the findings also reveal a number of tensions between what is intended and laid down in the curriculum and how it is managed and enacted. Subsequent chapters consider these issues in relation to the enacted General Bush fire-fighter curriculum. Whilst the emphasis in this thesis is upon how curriculum is organised, how trainers enact it and what challenges they face in doing so, it is important to consider what this means for learners. This was the focus of chapter 5.

Chapter 5 addressed research question 2: What are the perceptions of trainees about learning bush fire-fighting?

The discussion and analysis showed that trainees valued several key elements of the curriculum. Trainees appreciated the learning environment established in the practical sessions, which provided opportunities to actively engage in work-related skills, from the application of the simple rake-hoe to operating pumps and communication equipment, with scope for open discussion, questioning and hands-on practice.

The ‘Melbourne crew’ trainees (i.e., urban-based employees from head office), and other trainees who have limited bushfire experience, particularly valued the practical components of the training. As many of this cohort have limited or no rural or bushfire experience they appreciated the opportunities to engage with qualified crews and were keen to get as much skill-based experience as possible.

Two additional findings were identified. The first relates to the challenges trainees experienced with the formal classroom sessions, which included the *PowerPoint* delivery of the bushfire behaviour and other theoretical elements. Some trainees found the amount of information overwhelming and many were bored by frequent repetitions in the *PowerPoint* deliveries and tended to disengage. Trainees expressed concern about a perceived vagueness in the relative importance of various components of the content

presented. The second finding relates to the challenge of trainees' perception of the assessment process. On this level, several trainees expressed anxieties arising from a lack of feedback on their individual progress during the course. Trainees were not required to articulate what they had learned in the theory sessions until the oral and written assessments at the end of the course. Some trainees found the oral and written assessment process demanding, and this was especially the case for trainees who had not undertaken training, or studied in a classroom context, for a long time.

A conclusion drawn from the analysis was that learners tended to disengage with the training that relied on *PowerPoints* as a means of delivery and become passive. Whilst many trainees found the overall experience positive, some left this intensive 5-day training feeling underprepared for what they might be facing in the field.

Overall, it can be concluded that the responses obtained from the trainee interviews reflect the diversity of learning needs within the trainee cohort. This correlates with the concern trainers expressed about meeting the needs of a diverse group while seeking to “cover everything” within the relatively short duration of the training camp that was to provide the full course content for entry-level bush fire-fighters. This tension also relates to a possible over-reliance on a summative assessment process. Trainees themselves did not feel confident that they were indeed learning because they were not getting feedback on the theory sessions.

Chapter 6 addressed *research question 3*; What are the perceptions of trainers about how trainees learn bush fire-fighting? It was found that trainers expressed concerns in relation to changes to their work roles and training. These included the challenges arising from the additional demands mentioned previously and changes in the makeup of the training cohort being recruited. This is more diverse than in the past, with a wide variation in educational backgrounds and level of experience, many having limited previous experience with bushfires and some having no rural experience whatsoever.

These challenges, and the other curriculum demands discussed in chapter 4, impact on the learning environments that trainers are able to create. It was identified in that chapter that

aside from the practical training, trainers typically used a lecture-style delivery with an emphasis on instruction. Trainers are aware that trainees find the lecture-style approach challenging and they are keen to improve this situation.

The discussion and analysis also identified several trainer assumptions about learning and pedagogy. The findings include two common assumptions. The first was that trainers did not think that they should be gauging learners' progress during the vocational theory part of the course and that assessment was appropriate as a *summative* activity – making sure that the students had “got it” at the end of the training. Consequently, trainers prioritised checking that topics had been “covered”, with an assumption that if the presentation had covered the topic then the trainees should know it.

The second assumption is a general belief that practical skills should be the primary focus and that “real learning” takes place -- after the entry-level training program -- in the context of practical experience with bushfire, under the guidance of experienced personnel. However, some trainers expressed disquiet about whether the training achieves its goals and how the development of expertise is to be assessed. With respect to understanding the nature of bushfire behaviour, all attested to the difficulty of providing satisfactory curriculum delivery in the form of practical exercises and the limited theoretical understandings they may afford.

As has been discussed trainers typically rely upon a lecture-style delivery for the theoretical elements of the training, with an emphasis on instruction rather than a model that focuses on trainee learning. This at least in part is a pragmatic response to the time-pressured demands upon their work and training roles imposed by an increasingly diverse training cohort, numerous top-down changes to the curriculum content and additional organisational demands for record-keeping, compliance documentation, etc.

Chapter 7 addressed research question 4; How is the teaching of the science of bushfire behaviour currently enacted in the learning environment?

The chapter examined two approaches to teaching the theoretical fire science of *bushfire behaviour*. The first was a traditional lecture delivery, which has been the customary approach used in this training course. The second was a simulation-based activity used to teach this theoretical unit offered during the research fieldwork for the first time.

Observations and analysis of these contrasting approaches revealed several findings. Perhaps not surprisingly, the lecture approach used a teacher-centred approach with minimal interaction between the learner and the teacher and the second used a much more learner-centred approach. An analysis of the questions asked during these sessions supported these observations, both in terms of the number of interactions initiated by the trainers and the quality of the questions asked. For example, although the sessions were approximately the same length, in the traditional lecture delivery the trainer asked 12 questions in contrast to 61 questions that were posed in the simulation-based lesson.

In addition, it was found that 9 of the questions asked in the traditional approach were knowledge-based questions, asking learners to recall something covered previously, and 3 were slightly higher-order questions requiring some comprehension of the combustion process. In contrast, of the 61 questions posed to learners in the simulation session, most of these sought to reveal the extent to which the various concepts and information had been understood (40 questions in total).

It was concluded that in contrast to the traditional lecture-based approach used to deliver this part of the curriculum, the simulation-based approach was a much more immersive activity and when coupled with skilled questioning by the trainer had the potential to engage trainees at a higher level of comprehension and analysis. In addition, this approach engaged trainees more actively by having them make choices about strategy, with responsibility for the consequences of their decisions. Thus, this enactment of the bushfire behaviour curriculum may be more capable of realizing the higher-level learning goals that were previously identified as a critical and needed component of this stated and intended curriculum.

Chapter 8 addressed research question 5; What are the affordances of a situated immersive pedagogy in teaching the science of bushfire behaviour? It did this by providing a closer analysis of the simulation-based learning context afforded by the bushfire simulation apparatus.

It was shown that, when compared to the traditional lecture enactment of the *bushfire behaviour* component of the curriculum, the simulation-based exercise yielded different learning outcomes. It enabled an enhanced learning environment for trainees which provided opportunities for trainees to participate in activities which replicated typical workplace contexts and problems. This provided scope to access a range of relevant concepts, with a primary focus on the stated objectives of the curriculum concerning the science of *bushfire behaviour*. It was shown that through explicit reference to the key fire science concepts, learners can experience how these elements act dynamically and how they function within the environment. In turn, they experience how these concepts manifest in different operational contexts. The analysis has revealed that engagement in a goal-directed activity provided enhanced scope to link underpinning conceptual knowledge with its application to practical situations, facilitating adaptive thinking and the generation of new knowledge.

The findings support the view developed from the literature that it is through embedding learning in the circumstances of its use, and through engagement in work activities, that individuals learn (Rogoff, 1995), albeit in this case via a simulation of the work environment and activities. Learning through participation in the bush fire-fighting community of practice is recognised as an essential process of knowledge development by the trainers. However, in the context of entry-level training opportunities for participation in real fire events are extremely limited and the simulation exercise provides a valuable substitute.

These outcomes point to several direct implications. First, the higher degree of trainee participation encouraged in this learning environment affords opportunities for trainers to conduct formative processes of assessment in which they can probe the trainees' comprehension and adapt their instruction accordingly, leading to a better enactment of

the curriculum goals. Second, this is a learner-centered approach in which trainees are expected to voice their understandings and perceptions. This provides opportunities for learners to develop their own understandings alongside others which in turn assists them to develop their perceptual/analytic skills from an early stage of their training. This constitutes a subtle but significant change of pedagogy in the pursuit of more understanding-based bush fire-fighter performance.

Taken together the ideas of *learning with understanding*, the *transfer* of abstract ideas across situations and the need to incorporate *reflective learning practices* (Greeno, 1998; Schon, 1983; Resnick, 1989) are important to understanding how entry-level bush fire-fighter training may provide opportunities for trainees to understand the deeper principles of the science of *bushfire behaviour* and make critical decisions in relation to these principles across the range of situations they may encounter.

Therefore, it is concluded that when instruction is socially situated, as when the fire simulation exercise is employed to engage trainees and lift their thinking skills in application and analysis, trainees are able to become actively engaged providing more opportunities to access a higher order of understanding.

There are a number of practical, theoretical and research implications that arise from the findings of this thesis and these are examined next.

9.2 Discussion and implications

The outline above has synthesised the main findings presented in chapters 4–8. This section will discuss some of the implications of these findings for key stakeholders, which include trainees, practitioners, trainers, bush fire-fighting agencies and policy makers.

Within the activity of entry-level learning, it has been shown how a situated immersive pedagogy affords access to the skills and knowledge critical to entry-level bush fire-fighters. The analysis and findings of the previous chapter suggest important learning processes that enhance this learning model. The learning processes identified and conceptualised in this thesis include the processes of (1) immersive ‘noticing’, (2) the

overlapping and integrating of concepts and (3) participation and social engagement. This section further elaborates on how these conceptual learning processes operate to influence learning for this work domain. It does so by identifying central features of this model of pedagogical engagement and considering the implications of these strategies for application on a broader scale. Particularly, a conceptual framework has been developed that identifies the pedagogical skills needed for trainers to enact these learning processes. The following table (Table 19) provides a summary of this theoretical framework and sets out the features and some of the pedagogical elements afforded for learning entry-level bush fire-fighting.

Table 19: Influence of immersive situated learning processes on learning bush fire-fighting

PROCESSES OF LEARNING	IMPORTANT FEATURES	PEDAGOGY AND PEDAGOGICAL SKILLS
Immersive ‘noticing’ and ‘enacting’	Functional Dynamic Context-dependent Close guidance needed	<ul style="list-style-type: none"> • Importance of attending to and enacting environmental cues and clues (indexing knowledge). • Improvement in subsequent deployment of the knowledge. • Includes rich, shared conjectures about context and action (<i>perceptually-based knowing</i>). • Requires the modelling of expert practice.
Overlapping/ integrating	Schemas (pattern matching) Themed Integrative mental model	<ul style="list-style-type: none"> • Importance of ensuring good depth of job content knowledge. • Builds skill foundationally.
Building shared understanding through social and interpersonal engagement	Tacit Practical Micro-social actions Adapting traits	<ul style="list-style-type: none"> • Shared understanding/action. • The value of attending to the affective curriculum. • May represent aspects of an emerging communities of practice (Interdependent focus, ‘flatter’ hierarchy).

9.2.1 Using immersive ‘noticing and enacting’ learning processes

Immersive ‘noticing’ is a central learning component of the situated activity studied in the previous chapter. It was shown that learners were guided to closely observe the pattern of the bushfire, to notice how it shifts and changes and what aspects of fuel, weather and topography were related to these changes. This is an applied learning context in which learners are enabled to focus on the context-specific components of the ‘simulated’ environment, alongside the theoretical components, the theoretical understandings of bushfire behaviour. In this way, the behaviour of the bushfire and how the elemental components of the bushfire interact dynamically are drawn into focus for the learner. When a trainer facilitates immersive noticing, trainees are given the opportunity to engage with the specifics of the context and the propositional knowledge which they need to apply in relation to those specifics.

Thus, trainees are not only *observing* the value of using ‘noticing’ skills but are also being asked to ‘enact’ these skills. There are two aspects of ‘immersive enacting’ that are apparent and critical. The first is that trainees are immersed in dialogues and narratives about what to attend to (Bruner, 1991; Currie & Brown, 2003). These discussions mostly centre on deciding what *cues* need to be extracted from the context to help them decide on what information is relevant (Brown, Stacey, & Nandhakumar, 2007). For example, at the start of the exercise, the trainer coaches the trainees to consider different environmental aspects that might endanger their surrogate fire-fighters. Later as the bushfire progresses, the trainer models his own thinking through a narrative account of what they are facing and in doing so he builds a verbal ‘picture’ of what he sees, what might need to happen as a result of various changes and what effect they have on the developing bushfire. As the trainer does this, and through his questioning, he draws trainees into this ‘picture building’ exercise.

The second aspect is the level of focus expected of trainees. Trainees are encouraged to look closely at the *clues* that are apparent in the simulated surroundings and to describe what they ‘see’. The simulation (i.e. the physical apparatus) plays an important role in replicating the varied and subtle *clues* of the physical aspects of fuel, weather and

topography. This focus on these physical subtleties provides scope to start to build the detailed observational skills that bush fire-fighters need. Taken together, the focus on perceptual skills coupled with the search for *cues* and *clues* and the ‘picture building’ activities, reflect the cognitive/perceptual skills (Klein & Hoffman, 1992) that are pertinent to bush fire-fighters’ expertise and which need to be built through training and experience.

Additionally, indexing the *cues and clues* to the physical environment (Eylon & Linn, 1988) as well as the trainer’s representations of the knowledge, aids schema formation (e.g. honing perceptual skills alongside the developing cognitive structures). Research has shown that this rich and multi-fold indexing of knowledge - i.e. the linking of the social or physical circumstances to the organisation of knowledge - helps to build knowledge and improves subsequent deployment of the knowledge (Billett, 1998). This is supported by both the social/cultural learning and expertise literature (Collins, Brown, & Newman, 1987; Ericsson & Simon, 1984; Greeno, 1989).

An important implication for implementing *immersive noticing and enacting* processes in the training with the potential to build formative ‘expert’ skills is the requirement this places on trainers to have the pedagogic skill to conduct this type of training.

It is noted above that this learning context provides potential for building cognitive/perceptual skills. A key facet of this kind of skill building apparent in the immersive learning context is the relationships that are being established towards understanding the *context*. It is noticeable that what seems to drive the exercise is an active exploration and a deeper acquaintance with the context (Baron & Misovich, 1999). Learners are asked to encounter, interpret and act on the context. It could be said that the context is being ‘acted-on’ and ‘talked into being’. This accords with the phenomenological perspective of context (e.g., Garfinkel, 1986), in which reflexive meaning-making takes precedence; i.e. participants shape action in relation to context while the context itself is constantly being redefined through action. From this perspective, it is the meanings participants give to contexts, and their relationship to action that are important.

Whilst there is a focus on encountering and interpreting what is happening ‘here and now’, the *context* provided by the simulation is not depicted as a static object but as phenomena in flux. In this way, the context (phenomena) manifests itself and is subject to on-going interpretation.

The skill being modelled is the skill of ‘talking contexts into existence’, of perceiving interactional relationships between contexts and action. It is a reflexive ‘coming to know’ in relation to shifting and emerging phenomena. The cognitive processing demands are directed towards perceiving the richness of contexts; they are detail-driven, focused on the immediate interactional setting and require gaining a deeper acquaintance with changeable contexts in which the work is conducted. This *perceptually based knowing* (Baron & Misovich, 1999) comprises the type of *social sensemaking* that bush fire-fighters need to be able to participate in and manage when contexts become complex. *Sensemaking* in these terms includes the rich, shared conjectures about context and action which are the skills needed when trying to manage unexpected situations (Weick and Sutcliffe, 2015, p. 33). When incorporated as pedagogical elements, a *perceptually based knowing* approach require the modelling of expert practice. Thus, when trainers bring their thinking about action and context to the surface (Collins, Brown, & Holum, 1991), they make this less visible and more remote knowledge more accessible.

9.2.2 Using overlapping/integrated learning processes

As with the immersive ‘noticing’ strategy, the *overlapping/integrated* learning processes are afforded by the context-specific focus as well as the close guidance of the trainer. However, it is the simulation apparatus that provides scope for these processes to operate in this learning context. This provides the possibility for demonstrating a series of interlinking ‘bushfire’ events which allows a more complex pattern of social, physical and temporal *cues* to be observed and acted upon.

As examined in the previous chapter, an *overlapping* effect results when core learning objectives and themes recur across the ongoing events (or mini-cases), allowing different facets of the concepts/themes to be highlighted. These conditions expose learners to

different views of the same idea and provide opportunities to expand on or clarify initial understandings (Glaser, 1990). For example, as the fire moves across the fire-ground, and different situations evolve, the trainees are asked to reappraise their ‘safe’ positions in the light of the unfolding events. This provides scope for early perceptions to be reconsidered or to check on aspects of the knowledge in relation to its appropriateness when deployed in other circumstances. Thus, learners experience how knowledge is patterned across a dynamic and situated context and this provides the frame of reference to check their understandings as they consider new experiences (Posner, 1982).

However, the overriding intent is the illustration and articulation of the critical bushfire behaviour variables. As the bushfire changes, trainees are guided to see the salience of these variables as they stack up within specific situations. This helps to build understandings of the processes of how bushfire behave as well as supporting a more *integrative* mental model of bushfire behaviour (Lewandowsky et al, 2007). That is, they not only learn that fire moves faster up hills, for example, but are guided to consider how other aspects in the situation will interact dynamically or in concert with the effects of the terrain to impact the fire.

9.2.3 Framing social and interpersonal processes

A core strategy of the immersive situated learning context is the expectation that trainees are to actively participate in the activities. As discussed above, this takes various shapes. Learners engaged in this context are immersed in dialogues and narratives, they have opportunities to act upon the situated *cues and clues* and they are included in problem-solving activity. These are trainer-directed, and delivered through ongoing dialogue, ‘picture building’ and through directing the action. The third component is how the trainer gives direction to and frames the social and interpersonal learning processes. This includes establishing what is being privileged in the social practice (Lave & Wenger, 1991) and what is considered as valuable and effortful engagement (Goodnow, 1990). Three dimensions of these elements will be considered next and include the following; that learners are provided with a set of expectations and responsibilities; they experience

the role that practical judgements play in learning; and they experience how social actions are managed in non-routine problem-solving.

The first is that learners are provided with a set of expectations and responsibilities. As shown in the previous chapter, this includes introducing trainees to a set of expectations about how they *ought to perform* in this work role. For example, they learn about practical task-responsibility, that ‘noticing’ is an important and ongoing responsibility; that ‘noticing’ is a shared responsibility and that open communication can contribute to a group’s overall level of awareness. In addition to the focus on these interdependent skills, they are taught that adaptive behaviours are also critical. Being adaptive means attending to changes in the environment with the expectation that this may lead to a new set of decisions. In summary, they learn that they have an active and interdependent part to play in the decision setting and that their safety is dependent on their level of skill and knowledge in all these aspects.

The second aspect is the focus given to micro-social learning processes. It was shown in the previous chapter that trainees are asked to engage with the subtler, nuanced instances of practice and moment-to-moment practical judgments. As discussed elsewhere (see chapter 2, section 2) these are the fine grain mediational processes that operate at the interpersonal level and in which learners “gain facility in an activity” (Rogoff, 1995, p.15). Beckett and Hager (2000) define this type of decision making as the exercise of “*hot action*” decisions. These are typically practical judgments that are embedded in day-to-day activity, decisions about ‘what to do next’ and what is contextually suitable. This focus allows trainees to explore the instances of practice, what constitutes performance within it and how to effectively engage in these actions. As Hager (2000) notes these are the less visible parts of operational knowledge that mask a range of capacities important to workplace actions, especially non-routine actions required in complex workplaces.

The third component is the modelling of social action in non-routine problem solving. On this level, it becomes clear that although trainees are invited to enact decisions, the trainer is being judicious about what contexts in which to involve trainees. In the more complex situations he prefers to model what needs to be attended to and to discuss the choices that

are open to him. In these instances, the trainer extends the decision setting; he selects important features of the situation, discusses how this guides any action that needs to be taken, and at times, discusses these actions in terms of the wider goals and plans of the ‘crew’. Thus, he models more ‘mature’ examples of the decision-making practices of bush fire-fighters (Vygotsky, 1978).

This type of strategy means that trainees can be immersed in and make contributions to purposeful activities that have value to the community of practice (Lave & Wenger, 1991). It also attests to the value of attending to the affective curriculum so that learners experience what is considered valuable engagement in the domain’s practices (Goodnow, 1990). This includes gaining knowledge about the responsibilities and expectations when performing tasks. As this privileges active and interdependent levels of engagement, trainees are being invited to participate as legitimate partners (Lave & Wenger, 1991).

9.2.4 Implications

The direct implications of using these approaches are twofold. The first is that trainees need to explore the instances of practice, what constitutes performance within it and how to effectively engage in these actions. These should include engagement with the (simulated) day-to-day actions and problems as well as higher orders of engagement (more mature practice). Secondly, by engaging trainees in activity pertinent to this skill, and at different levels, learners can access how different behavioral/cognitive accomplishments are enacted and start to gain access to aspects of the skills that are needed and relevant to the trainees’ post-training development.

9.3 Recommendations for future research

The findings reported in this thesis are based on a qualitative case study of an entry-level training setting in one type of bush fire-fighter organisation, a land management agency. While this constrains generalisation, it is contended that these findings plausibly relate to training contexts in other bush fire-fighting agencies and indeed may have relevance to other complex work environments. Documenting the factors which point toward improving the pedagogy for this field of workplace learning does not provide a ready-

made “solution” to training problems – the context-specific nature of training and educational life means that trainers and students must judge the applicability of the findings and recommendations made - but helps to open discussion about their relevance to this and other analogous training environments.

While workplace learning is a major factor in the growth of the individual worker, assisting his or her personal development, some workplace environments, such as those confronted by first response emergency workers, wherein crucial decisions must often be made “on the fly”, are inherently complex and hazardous. Understanding the nature of these work environments and the development of the expertise needed to manage with them is complex (Ross, Shafer & Klein, 2006) and assumptions and generalisations about learning in less complex workplaces do not always suffice to reveal the development of critical thinking and the capacity for rapid responses needed in emergency situations.

The previous chapter has noted the benefit of laying out a detailed context-specific pedagogy from which to formulate the details of the *pedagogical content knowledge* (Shulman, 1987) needed to address the demands of this workplace. It also attests to the value of mapping the implications for curriculum across the whole of the bush fire-fighter’s journey from novice to expert. There is much practical and research work to be done and it is hoped that this study may stimulate further research and provide practical springboards for developing understandings in pedagogy, curriculum and learning that occurs in this practice. Their relevance could be tested in other environments where work activity involves high performance work, for example.

As previously noted, various references have been made to the organizational culture or *community of practice* of the land management agency which conducted the training observed in this study. The training camps presented an ethos of inclusivity with no observable gender discrimination and positive assistance for trainees with literacy problems. However, this may not be typical of all bush fire-fighting workplaces and a broad ethnographic study is needed to reveal the culture of the bush fire-fighting service and its educational practices, particularly with respect to its influence on the development of novice bush fire-fighters subsequent to their entry-level training.

A closely related subject for future research would be to follow the progress and experiences of a group of novices after their entry-level training. Here rich avenues for consideration would include the level and quality of engagement and interactions with expert practice and mentoring, the depth of negotiations of understandings and the degree to which the conceptual aspects of the curriculum are embedded, utilised and transformed through practice, including the impact of new pedagogies on progress.

Workplaces have obvious strengths as learning environments in which the knowledge and skills required for work performance can be acquired. Adult learning theories of situated learning, simulation and case-based learning and community of practice are helping to clarify these strengths and elucidate some of the problems. It is hoped that this thesis points to the value of employing these concepts as tools with which to examine the workplace culture in the future research suggested above.

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APPENDICES

Appendix A

Semi-structured interview questions

The following questions relate to general training practices:

- Describe a typical session when you are training. Describe why you have chosen to teach it this way?
- How long have you been using competency based training approaches? What is your opinion of this approach to training?
- When preparing for training sessions what resources (e.g. training manual, PowerPoint software) do you use?
- What do you consider the strengths and weaknesses of training approaches used and current curriculum and assessment?

The following questions relate to subject specific training:

- What units do you teach?
- If any of these units include training in bushfire behaviour, could you talk a little about the unit, what it involves, who takes part in the training, what you are aiming to develop in your trainees, what your goals are?
- Are there any aspects of training in bushfire behaviour that is difficult to get across in a learning setting? What aspects do your trainees really struggle with?
- Are there any aspects of training in fire behaviour that you've had particular success with? Can you describe how you approached this training and why you think this was successful?
- What resources do you and your trainees use in bushfire training?
- What other concrete materials/demonstrations are used?

The following questions relate to trainee learning capabilities.

- What are some of the difficulties you think hinder your trainees' learning?
- What are some of the strengths that help progress your trainees' learning?
- What do you believe are the core qualities needed for trainees to be successful?
- What do you see as the core understandings and knowledge needed for your trainees to be successful?

Appendix B

Sample information sheet and consent form



Faculty of Education
Private Bag 66
Hobart 7001



UNIVERSITY
OF TASMANIA

Date

I would like to invite your participation in the following research:

Applications of multi-media education strategies in bushfire behaviour training

Annette Salter (PhD researcher) is seeking to understand the ways in which the use of ICT tools, influence teaching and learning practices in bushfire behaviour. This project is one of a number of national projects being funded by the Bushfire Cooperative Research Centre (BCRC). The chief investigator for this project is Dr Christine Owen (Assistant Dean, Faculty of Education, University of Tasmania & Program leader: Education and Training; Project Leader: Enhancing Information Flow and IMT effectiveness Bushfire CRC).

This study aims to investigate how trainers develop their expertise when developing and implementing ICT tools and resources (ICT stands for information and communications technologies and refers to the technologies that can assist teaching and learning, e.g. interactive software, video, simulation systems.) There is limited research into this field, especially in training settings, and the results of the study will provide invaluable understanding into how to approach the professional learning of trainers who deliver instruction in workplace settings, especially when trainers are using ICT tools.

Taking part in this study provides you with an opportunity to develop learning tools and resources in 'bushfire behaviour' training and accompanying teaching strategies and to further develop your team's delivery options and tools. Participation is entirely voluntary, and if you choose to take part you will need to read and sign the content form attached to this information sheet.

What am I being asked to do?

- In the first phase of the research, we are asking if we might be able to interview you and for you to complete a short questionnaire to gain information about your current training strategies, your views about teaching and learning, your confidence with using ICT tools, and how you teach ‘bushfire behaviour’ training. It is expected this interview will take approximately 40 minutes and with your permission will be taped (questions will be provided to you before the interview). The questionnaire should take about 15 minutes to complete.
- Some trainers will also be asked if it would be possible for the researcher to observe their training sessions. The observation will involve the researcher sitting in on their training sessions and videoing a pre-agreed session (about 20 minutes). The trainer will be asked to provide the researcher with copies of teaching materials and tests undertaken by trainees. Trainers being observed will be asked to assist the researcher to circulate an information sheet to trainees who will be asked to self-nominate to participate in a short interview.

In the next phase, you will work to develop ICT resources and/or plan teaching and learning approaches. The approach we will take to developing these resources is called a design or problem-based approach. This is a learning-by-doing approach in that you select a real world problem that you would like to improve in your current training approaches and as you develop a solution to that problem you will be building on your trainer techniques and strategies.

Your progress with this project will be supported in the following ways...

- An initial workshop where the ‘design’ project will be established and strategies for approaching the ‘design’ discussed
- Ongoing support from the researcher in using ICT instructional tools.
- Where appropriate, further workshops may be organised to share and review progress or introduce new strategies or technologies

It is hoped that once the resources have been completed that a trial of some of these resources will be conducted. This will involve Annette visiting your training area; to take notes about how you and your trainees use this tools or resources.

During these phases Annette will be collecting a range of data to understand how this process provides benefits to you and your trainees/practitioners. In order to keep track of progress Annette will be collecting a range of information and this may include taking photographs or videoing your teaching. The photographs and videos will be viewed and analysed by the researcher. These will **not** be published in any shape or form.

In summary, taking part in this project means you will be asked to:

- Take part in a 40-minute audio-taped interview and complete a questionnaire (approx. 15 minutes to complete) at a time to suit you.
- Participate in an initial workshop to get feedback from early observations and to establish the design project they you will be working on. (some photographs may be taken during the workshop)
- Co-develop ICT tools and/or plan teaching and learning approaches
- Complete a short questionnaire 2 or 3 times during the 'design' stage
- Undertake a trial session using the ICT tools developed and allow the researcher to observe. Assist the researcher in circulating an information sheet about the research to trainees with the purpose of getting trainees to come forward to undertake a short interview. (Only one or two sessions will be observed thus not all trainers will be asked to do this.)
- Undertake a post-trial profile similar to the first interview and questionnaire (taped interview and short questionnaire)

If you agree to take part in this research please complete the attached tear off slip, place it in the self-addressed envelope and return to me via mail (email, fax or phone if desired – details below).
Will I be identifiable?

No personal information will be sought, recorded or published. Only data that has been aggregated will be made available for publication and review.

How private is the information that I give?

Interviews and notes will be coded with numbers and dates, no names will be written on the interview transcripts and observation notes. This de-identified data will be stored in a locked filing cabinet and on the password protected University of Tasmania, Faculty of Education server. I am required to keep this information for five years from the date of publication of my thesis publication book.

Are there any potential risks or discomforts to me?

We have thought carefully about what possible risks there might be for you and we have identified the following possible risk.

Risk of harming professional standing

A component of this study is to find out more about teaching practices within the fire and land management industry and some trainers may be asked to allow an observation of a training session. There is a potential risk to your professional standing if your manager/supervisor learns of any training practices observed during the recorded interview that reflect poorly on your professional practice.

How will this possible risk be minimised?

Management will be advised that they will not have access to any raw observation data collected as part of this study. We will make sure that no identifying information is included in the observation transcript by ensuring that any discussion/observations that could identify you in particular will be removed or changed. No-one other than those authorised by the University ethics committee will have access to the observation recording. These staff includes the researcher, Annette Salter and the chief investigator, Dr Christine Owen.

Can I withdraw from the research if I wish?

Prior to taking part in the research, you will be asked to sign a form giving your consent to take part. It is important to note that your participation is entirely voluntary; you can withdraw at any time, and do not need to provide any explanation for doing so. You may also withdraw any data you have contributed to the research.

Contact details of the researchers:

Chief Investigator:	Christine Owen Assistant Dean, Faculty of Education, University of Tasmania & Program leader: Education and Training; Project Leader: Enhancing Information Flow and IMT effectiveness Bushfire CRC Telephone: 03 6226 2555 Fax: 03 6226 2569 Email: Christine.Owen@utas.edu.au
PhD Researcher:	Annette Salter Telephone: 03 62 26 7880 Fax: 03 6226 2569 Email: Annette.Salter@utas.edu.au

This project has received ethical approval from the Human Research Ethics Committee (Tasmania) Network which is constituted under the National Health & Medical Research Council. The Committees under the HREC (Tasmania) Network use the *National Statement on Ethical Conduct in Research Involving Humans* Guidelines to inform their decisions. If you have any concerns of an ethical nature or complaints about the manner in which the project is conducted, you may contact the Executive Officer of the Human Research Ethics Committee (Tasmania) Network. The Executive Officer can direct participants to the relevant Chair of the Committee that reviewed the research.

Executive Officer: phone (03 6226 7479) or email human.ethics@utas.edu.au

This is your copy of the information sheet, and if you agree to take part, you will also be given a copy of the consent form you will be asked to sign.
Thank you for reading this information sheet and I hope you are willing to participate in the study.

Kind regards

Annette Salter

Should you agree to take part in this research please complete the form below.

I _____(name) would like to take part in the
research project *Applications of multi-media education strategies in fire
behaviour training.*

My work phone number is: _____

My email address is : _____

I would like advice about any publications from this research: (please tick the appropriate box)

☐ Yes ☐ No

If yes, please put your address here _____

Once Annette has received your form she will contact you by phone or email to make arrangements for a suitable time to interview you.

Appendix C

Training observations protocol

Real time observations were conducted of a number of units conducted in the training camps. This protocol was used to organize my notes on these observations.

Trainer Observed _____ Date of Observation _____
Course Observed _____

Classroom Teaching Observation

CONTENT

Main ideas are clear and specific
Sufficient variety in supporting information
Relevancy of main ideas was clear
Higher order thinking was required
Instructor related ideas to prior knowledge
Definitions were given for vocabulary

COMMENTS

ORGANIZATION

Introduction captured attention
Introduction stated organization of lecture
Clear organizational plan
Concluded by summarizing main ideas
Reviewed by connecting to previous classes
Previewed by connecting to future classes

COMMENTS

INTERACTION

Instructor questions at different levels
Sufficient wait time
Students asked questions
Instructor feedback was informative
Instructor incorporated student responses

Good rapport with students

COMMENTS

USE OF MEDIA

Overheads/chalkboard content clear & well organized

Visual aids can be easily read

Instructor provided an outline/handouts

Computerized instruction effective

COMMENTS

STRENGTHS: (e.g. use of comparisons & contrasts, positive feedback, opportunity provided for student questions)

WEAKNESSES: (e.g. unable to answer student questions, overall topic knowledge, relevance of examples, etc.)

Date of Training_____

Appendix D

The bushfire behaviour unit outcomes against the Bloom's levels

THE BUSHFIRE BEHAVIOUR UNIT OUTCOMES	BLOOM'S LEVEL
On successful completion of this session the trainee will be able to:	
1. Describe how materials burn.	Knowledge
2. Identify the elements for a fire to exist.	Knowledge
3. Describe one common method to control each of these elements	Knowledge
4. Identify three methods of heat transfer.	Knowledge
5. Describe the development of wildfires.	Comprehension
6. Explain the terms: Point of origin, Head Fire, Flanks, Flame height, and Rate of Spread.	Knowledge
7. Describe the difference between a Ground Fire, a Surface Fire and a Crown Fire.	Knowledge
8. Describe what happens to the rate of spread and intensity as a fire develops.	Comprehension
9. Describe Spotting and its causes	Knowledge
10. Identify the three basic factors which affect fire behaviour and describe the general effects of each.	Knowledge
11. List the three general factors that affect fire.	Knowledge
12. List the five main fuel factors that affect fire behaviour and describe how each affect fire behaviour.	Comprehension
13. List the two main topographic factors that affect fire behaviour and describe the general effects of each.	Comprehension
14. List the four main weather factors that affect fire behaviour and describe the general effects of each.	Knowledge
15. Describe the relationship between wind speed and direction, and the shape of a fire.	Comprehension

Appendix E

Background details of the trainees interviewed

The following table provides an age, gender, experience and educational profile of the 22 trainees interviewed across the 3 camps. There were 80 trainees in total that attended the 3 camps observed.

Table 20: Summary of the characteristics of trainees interviewed

CHARACTERISTICS OF THE 22 TRAINEES INTERVIEWED		
AGE		
	17-30 years of age	13
	31-40 years of age	5
	41 and over	4
GENDER		
	Male	16
	Female	6
EXPERIENCE WITH 'FIGHTING BUSHFIRE'		
	Some experience	14
	No firsthand experience	8
HIGHEST LEVEL OF EDUCATION ACHIEVED		
	people had not completed Year 10	2
	people who had completed Year 10	4
	people who had completed Year 12	4
	people who undertaking or have completed a University degree or above*	12

In brief the profile of the trainees interviewed is as follows,

- Of the 22 trainees interviewed the majority (13/22) were aged 17-30 and the rest were distributed across the other age groups.
- Mostly male trainees made up this profile (16 males to 6 females).
- The majority of trainees interviewed, 14 out of 22, have some experience with 'fighting fire' but 8 did not have any firsthand experience.
- A large number (12 out of 22) had a degree or above (or were working to complete a degree). 4 people had completed Year 12, 4 had completed Year 10, 2 people had **not** completed year 10.

Appendix F

Script of the approach using the situated, immersive learning approach

	Video times	Timespan	Action/gesture	Instructor	Trainee
Introductory section	48:45	0:00	Indicates fire on table Indicates flanksnot a purest dead man's zone, but anytime that there is any fuel between you and the fire you are gonna have a problem. That might not be a pure dead man's zone where the flank changes,(inaudible). That's why we try to stay as close to the fire as we can. To try to work with the fire is our safest strategy, a direct attack on the flanks because the fire can't (inaudible)	
		0:28			It could jump over the top of you
			Indicates area of back-burning	Well it doesn't matter you just walk back on the fire, cause you are blackening out ..you just walk back in there. It can't burn twice. It's when we can't walk back is the problem, so when you are out here and it jumps over the top and you actually can't go either way - then you are pretty well screwed. OK we're on weather..we've had wind and temperature...and what's another weather factor	
		0:44			Rain
		0:55		Yes rain will affect fuel moisture content, so if there's rain we ain't gonna get much fire. All our fires are ended by rain , so the fire will pretty much burn to an end.	
		1:03			(inaudible comment)
				That fuel moisture content that makes a difference to itor the weather we've had in the past few days, weeks, months...seasonal drought – all have an impact on the ability of the fuels to burn	inaudible
		1:30		You started to talk about it before, where the convection column punching through an inversion layer and it sucked in more air. For that convection column to form....what caused that convection column to form?	

	Video times	Timespan	Action/gesture	Instructor	Trainee
Introductory section (continued)	48:45	0:00	Indicates fire on table Indicates flanksnot a purest dead mans zone, but anytime that there is any fuel between you and the fire you are gonna have a problem. That might not be a pure dead mans zone where the flank changes,(inaudible). That's why we try to stay as close to the fire as we can. To try to work with the fire is our safest strategy, a direct attack on the flanks because the fire can't (inaudible)	
		0:28			It could jump over the top of you
			Indicates area of back-burning	Well it doesn't matter you just walk back on the fire, cause you are blackening out ..you just walk back in there. It can't burn twice. Its when we can't walk back is the problem, so when you are out here and it jumps over the top and you actually can't go either way - then you are pretty well screwed. OK we're on weather..we've had wind and temperature...and what's another weather factor	
		0:44			Rain
		0:55		Yes rain will affect fuel moisture content, so if there's rain we ain't gonna get much fire. All our fires are ended by rain , so the fire will pretty much burn to an end.	
		1:03			(inaudible comment)
				That fuel moisture content that makes a difference to itor the weather we've had in the past few days, weeks, months...seasonal drought – all have an impact on the ability of the fuels to burn	inaudible
		1:30		You started to talk about it before, where the convection column punching through an inversion layer and it sucked in more air. For that convection column to form....what caused that convection column to form?	
					(inaudible comment)
	50:39	1:54		Yeah its something like that. For a convection column to form, there's hot air rising, rising, rising, making an unstable atmosphere. We have two sorts of atmosphere, stable and unstable. Stable atmosphere is a pocket of air for the first k between earth and the stratosphere that's all of the same temperature. So hot air rises, hits that mass and just spreads out (you can see that at Yallourn with the smoke and steam from the chimneys just spreading out)...(inaudible period)...punches through the inversion layer and air gets sucked in at the bottom. When you get up in the morning and they say we've got an inversion layer that's about a parcel of air very close to the earth. Very quickly the fire will burn through that layer and may punch through a bigger parcel of stable air and you'll see a column of smoke and you've got a major convection column	

	Video times	Timespan	Action/gesture	Instructor	Trainee
Introductory section (continued)		3:32			Night-time, is the fire hotter?
				No you've got cooler air. That tends to cool down the fire, slows the combustion process...its the best time to do (back)burning, historically. The temperature's lower, air's cooler and moister so we do our best work at night. One last weather factor...	
		4:05			Humidity?
				So what's humidity?	How much moisture is in the air
		4:10		That's right ...so how does that affect fire?	If everything is really dry it will easily burn
	53:03	4:18	Picks up a handful of dry fuel	Ok, so when we have 80% RH what does that mean?...Basically it means our parcel of air is 80% moisture. So what does that mean for this fuel?	It will be less dry
				Yes because this fuel will suck some of the moisture out of the air and become too wet to burn, too wet for the combustion process to take place. But with 10% RH what will happen to this fuel?	It'll dry out
	53:44	4:59		Yes, because it will give up its moisture to the air...the lower the RH, the quicker this fuel will burn	

	Video times	Timespan	Action/gesture	Instructor	Trainee
Segment 1: Personal safety on the fire-ground	53:50		Issues toy bush fire-fighter to each member of the group Indicates ignition point on table Students mill around table, deciding on safe locations	Ok, now comes the fun bit. Take your little man and put him somewhere safe on this table. I'm going to light a fire from up here so your knowledge of fire behaviour now should be directed towards safety	
	55:49	7:04		Ok what have we got? Let's look at these two here...what's your theory?	We're down in a gully cause the fuel's pretty moist down there
	55:52		Indicates path of fire, leading to an uphill section of stacked fuel	Ok, our fire's going to be going down the hill so that should be alright. When it goes up the hill, here, what's going to happen at this point?	It's going to start speeding up
				A lot or a little...	Depending on the wind on the day... but it's going to start picking up.
	56: 30		Points again to the stack of trees behind the 'bush fire-fighter' up the hill	What's the relative flame height to distance away did we say is needed to protect yourself from the radiant heat? [The trainer looks directly at another trainee for an answer]	Four times the flames height.
			Points back at the stack of trees and looks at the first trainee and smiles...the penny drops and the trainee laughs nervously, other trainees laugh in awareness of his predicament.	Ok, hold that thought and then look at the flame height here	The trainee, whose 'bush fire-fighter' is in the gully, laughs nervously.
	56:56	8:11	Indicates location on other side of down-wind ridge	These two over here...what's the theory? I see you've got them behind some vehicles.....good thought.	I imagine the fire is moving in this direction [he moves to the table and makes a hand gesture along the 'imagined' fire-line] and I will be on the flank.
			Addresses another student	This one I'm touching here –What's the thought?	Inaudible response

	Video times	Timespan	Action/gesture	Instructor	Trainee
Segment 1: Personal safety on the fire-ground (continued)		8:34	Another student	So, fire coming down here...fire passes on the other side. When the fire passes you move to the other side, so watch that. Same sort of thought here? It works in theory..a little bit harder to manage because the radiant heat is going to be pretty fierce and you may not be able to put your hand in there to save that person – but the thought process is right – protect yourself from radiant heat	
			Addresses another student	(inaudible question)	Inaudible response
			Moves to upwind end of table	Ok that sort of works and you can always walk over to the clearer ground. We don't seem to have 15 people on the ground..oh there are a couple over here...what's the theory behind that position? Behind the trailer?	There's an escape route, Theoretically that's safe
				Ok (student's name) has decided that houses are good protection	I didn't put mine up here because it shoots up the hill quick. I thought it would be better down in the gully with a mineral break around it[first trainee questioned who put his bush fire-fighter in the gully, says this unprompted – as if he's been thinking about it and keen for others to hear].
	58:30			Does that change anyone's thinking, with a fire-truck involved? No?	No reply...

	Video times	Timespan	Action/gesture	Instructor	Trainee
Segment 2: Fire suppression techniques	58:53	10:08	Tutor searches for toy fire truck and places on table Hands out spray bottle to student. Points to helicopters location	Ok. We don't want you to die so young in your career as bush fire-fighters, so you are a helicopter operator up there. When we get to call you for helicopter support you get two squirts every minute. Helicopters carry 800 – 1000 litres – so a small one like Elvis - so each squirt is worth about 400 litres. And I will call you when we need a helicopter. Keep your gloves on because you might need to get to the fire in-front of the flame	
	59:45	11:11	Gives second spray bottle to another student Places tanker near houses on ridge	You're a tanker; the tanker that was up here (can't see it at the moment). You've got ten squirts. The tanker holds about 4,000 litres but you can only work off this road here – the main job is to protect these houses. We'll tell you when we want you to squirt. See some of these houses have done a fairly constructive job of clearing but this one here hasn't so the process of defending their house[points to third house] might be a bit dodgy.	
	60:02	11:57	Gives a third spray bottle to another student. Points to slip-on	You're the slip-on, and your job, when he's working like that, is to protect this dozer here but you only get one squirt per minute. It's all about protecting the dozer and the crew; it's not about fighting the fire..... it's about safety.	
	60:06		Assigns another spray bottle	You're with the tanker up here. You've got ten squirts to protect the houses on this ridge. But note that through here we have a phos-chek ²³ . It's a chemical the DSE ²⁴ uses in our helicopters, we go through an aerial in the form of a bomb – you'll see it in the aircraft session. What the phos-chek does is it's a chemical which stops the combustion process, so that no amount of heat we apply to this fuel will make it burn. It might work...with the phos-chek, the mineral break, help from the tanker and some helicopter assistance, there's a fair chance even on the slope, we might be able to save these properties even though they're at the top of this slope	

²³ **Phos-Chek** is a particular brand of fire retardant.

²⁴ DSE (Department of Sustainability and Environment) was the name of this land management and fire-fighting department at the time this data was collected.

	Video times	Timespan	Action/gesture	Instructor	Trainee
Segment 3: Exploring the range of effects on the bushfire	61:01	12:55	Prepares to light fire	Ok is everybody ready? Bush fire-fighters, got your gloves on? We don't want you to burn your hands...(just the people with the spray bottles).	Inaudible comment
	62:05		Points to men in the gully previously mentioned by a student	(Jokes)If you die on the table we have to take points off your award. It's only Day One so ...this is where you learn, so there'll be some valuable lessons learned around the table.' Cause they [the toy 'bush fire-fighters'] might survive...but they've got to walk up a fairly steep slope here. [points to first gully 'bush fire-fighters' again – and uses his hands to signal the potential escape route up the slope]	Laughter
	62:24	13:46	Lights match and ignites dry leaves in the gully	Ok, if we had a lightning strike, this would be an initial point of ignition. Now for first attack, if we get to these fires quickly, we've got a chance of putting it out. So we try to get in there really quickly, so we would probably. Probably... we have lightning detectors and other sorts of things and have a look at that fire. If we came in with a helicopter attack now, which is what we do, we could put that out.	
	62:58	14:13	Addresses "helicopter" student	Get in there and have a crack at it.	
	63:20		Student administers the two squirts but fails to extinguish the fire	Bahh [trainer's response to the fire that continues to burn], that's lost but you can see it's just full of fuel [points to the fuel in the centre of the fire]...but if it wasn't so full...let's do another one. We'll leave that one burning and we'll have two lightning strikes.	
			Lights another fire nearby	I'll just light one here. Let that match burn out. Ok the fuels are alight now. So "helicopter" see how you go with that one.	
	63:40		Helicopter student administers two squirts and extinguishes flame	So if we get a fair crack on first attack and then a crew comes in to rake-hoe around it. But once the fire gets too big, the helicopter's not going to do any good.	

	Video times	Timespan	Action/gesture	Instructor	Trainee
Segment 3: Exploring the range of effects on the bushfire (continued)			Indicates original fire	Have a go at this one [points at the original fire]...see if your two blows will do anything	
	64:00		Two squirts only partially extinguishes fire which continues to accelerate up the hill	Ok let's just see what happens. The water slowed down the head of the fire but the radiant heat from the rest of the fire evaporates the water and it's starting to look a bit shaky up here on the retardant line. But we're thinking the retardant line is going to hold...we've got a tanker here, a good captain here[points to 'bush fire-fighters on the hill] and he's saying we're fairly comfortable... a bit of radiant heat and you can feel the convection heat coming up there[holds hand forward of the fire]. But it's all looking pretty good, so far.	
	64:25	15:40	Indicates shape of fire Indicates point of origin	We don't panic. We try to save our water, a scarce resource. We only put it in there when we need to go. See the shape of the fire? It's almost text-book. Started at ignition point of origin, backed away from that (point of origin was in here, somewhere). It's going out, influenced by a bit of wind and a bit of slope	
	65:05	16:30	Indicates North-South axis	That's North-South there..what wind is driving this fire?....Yes, it's an easterly wind and the fire is heading where?... West. So a Northerly wind drives the fire South and a Southerly pushes the fire North.	Various responses. ...easterly wind West.
	65:32	16:47	Uses a small stick to point to the Point of origin. Indicates progress of fire toward retardant line Indicates lengthening flames Indicates buildings at top of hill	Ok so it's looking pretty good and our suppression effort has worked so far. So asset protection, so priorities at [names the agency] is bush fire-fighter safety first. If we're going to come and tackle this fire we'd come back to the point of origin at the heel and start building a line around that fire [signals indirect attack line along edge starting from the heel of the fire]. See the radiant heat that's happening around here. We're going to have to deal with radiant heat all the time. When we talk about flame height, that's the sort of thing we mean when it's running up the hill....it's looking fairly comfortable here ...looks like our line is going to hold... there's a fair bit of heat back here but nothing too bad	

	Video times	Timespan	Action/gesture	Instructor	Trainee
Segment 4: The factors affecting a developing fire	66:32	17:40	Indicates a notional Nth-Sth line of fire	Ok, if we had one point fire, a spot fire, its pretty easy to get to. What would be the difference if we had a line fire? Where the fire has had a chance to develop and there's nothing to impede it?	It'd be going faster?
				Why?	There's be more heat
				And what is that heat doing?	Making the (inaudible)
				Because of?	Igniting the fuel
	66:58			Its heating the fuel, releasing the gases, so the more fire we have,. The bigger the fire will get, so I'll show you...I'll light a line of fire over here but we'll let this come through the stringy-bark first.	Jokes about the danger of the oncoming conflagration
	67:05	18:20	All watch the progress of the fire Fire burns back to the stacked material on steep ridge Nth of point of origin	You would have had the chance to move yourselves into a safe zone... the fire's just spreading out. It's got nowhere to burn up here (at retardant line) so it's just backing away, influenced by a bit of wind and a bit of fuel...see those green leaves? They're still burning – getting hot enough to release the gases in them Now it's crowning and it's not just the energy stored in the leaves but also the oil that's doing that flaring and flashing. It's already making all the sounds and when we have a crown fire there's a roar as those gases explode	
				Now it's reached the stringies. Why are the stringies burning so well?	(Inaudible)
	68:22	20:11	Fire size increases dramatically	Yes. It's also a very fine fuel...lots of oxygen. You can see how the fire is generating its own heat now. The heat has torched all of those leaves...	It's getting pretty hot where we are!
				Helicopter – see if you can sort that out	
			Helicopter squirts are ineffectual	Tanker?...That fire's beyond putting anything out so as bush fire-fighters we look for some strategic spots to fight the fire and that aint one of them!	laughter
			Points to area still burning in the gully near two of the toy bush fire-fighters	Now there's no direct flame contact here...helicopter, come in and put out that flame to stop direct contact in the front there, to see if the radiant heat kills those bush fire-fighters	
	69:00		Helicopter squirts are ineffectual Indicates another toy bush fire-fighter	Oh God, the one on that side's gone So if you're up-slope, surrounded by fuel, you're going to get the full monty of everything there..make sure these guys..(more helicopter squirts) let's see if the radiant heat gets them...this one's in direct flame contact...helicopter see if you can get it...I think they're dead	Laughter Cries of dismay
	69:22	22:03	Hessian underlay is now aflame and tanker squirt bottles are called in	We've got a bit of action over here (indicates houses at top of ridge). We might need to sacrifice the house...sometimes the fuel will beat you...its ok now there won't be any more embers we can save the house...	

	Video times	Timespan	Action/gesture	Instructor	Trainee
Segment 4: The factors affecting a developing fire (continued)	70:00	22:41	Main fuel mass on slope is now burnt away	ok leave that, we've got to wait two minutes before you can use the water again	
	70:04		Indicates area of stacked stringy-bark Indicates initial east-facing slope	Ok what's come out of it...the fuel factor. Once we had too much fuel nothing was going to suppress it Or too much slope	
			Positions line of incendiary material across the table	I was going to light a line fire across here but we'll let it light itself	Various inaudible comments
				That's why you don't drop helicopter water on the houses. Change it to a jet of water. A jet is more effective, but when you do it (inaudible) a mist of water evaporates a lot easier...	
			Points to flame action near top of central ridge (wind is now westerly)	Ok so what's influencing this fire now? Ok but the wind's changed again, pushing it this way with the slope – so wind and slope all working together. We should hopefully see a change across over the hill	The fine litter
		24:19	Indicates silver-top log unburnt by the fire	Just a matter of interest – the stringy bark really blazed but the silver-top, a different fuel type, needs a lot more heat to ignite the bark	
	72:15	24:51	Fire is burning over the ridge and incendiary line is now aflame. Wind intensifies and fire begins to move downhill	[looking at watch and aside to assistant] This is actually taking longer, why is that? They must have asked more questions	
	71:24		Points to green leaves beginning to burn	See these...as the fuel generates more heat they begin to release gases and burn	Have we had any people who've survived so far?

	Video times	Timespan	Action/gesture	Instructor	Trainee
Segment 5: Bush fire- fighter safety and fire suppression techniques	1:15:36 73:06			Yes, these ones over here behind the middle of the trail, down in the gully	
			Indicates area where bush fire-fighters "died"	These one's over here...a bigger fuel hazard and the fuel type was totally different...and the flame height of that (stringy bark) caused the problem	I thought I was alright over there til the hessian started burning
				(Assistant) the hessian is fuel load (Tutor) Yes the hessian is the surface fuel	
			Fire is burning more slowly down hill	This should quietly back down the hill	
	74:27	26:23	Indicates bush fire-fighters in gully beneath the fire	Now, we've got a couple of people down here. So remember you've got to decide when you think you're not going to get the radiant heat...	
			Points to previous stringy-bark area	what killed those ones – was it the radiant heat, bark falling on top of them or the actual flame?	Various inaudible responses
				They also had a big chunk of bark fall on them!	
			Indicates retardant fire trail area	Our mineral earth fire trail worked quite well When the group's divided – like you're group 2 and they're group one – do you ever work together?	Just the luck of the draw
				(Assistant) "I divided them" (Tutor) So this is not all the Melbourne Water people or all the.. (Assistant) "No – getting them to work with different people" (Tutor) So is here any difference between the two groups? (Assistant) No I went down my list and went group 1, group 2, group 1	

	Video times	Timespan	Action/gesture	Instructor	Trainee
Segment 5: Bush fire-fighter safety and fire suppression techniques (continued)				Ok how are those bush fire-fighter looking from the radiant heat point of view?	
			Adjusts position of toy fighter behind log	What we don't want is for the fire to start burning under there. we want to keep him away from direct flame – no one is stupid enough to stay in direct flame. If we got a helicopter in now there'd be a fair chance of saving him, so, helicopter, get in there	
	1:16:55 76:14	28:10	Helicopter gives two bursts	Alright, well there's just enough heat to (inaudible)	
			Removes the two bush fire-fighters from the danger zone	Over there there's (inaudible) we'll get them...ah so (inaudible) (Assistant) I'll grab that if you want No its alright	
		29:01	Indicates people in cattle-yard and then removes them	These people here, with fire backing down the hill are threatened but they've got scope to move out of the way, so we'll just do that	
		29:22	Uses drip torch to light a line of fire in the gully in the path of the approaching fire. This back-burn appears to be effective	So what we're doing in the way of suppression over here is that we've got a slip-on (?)	
	1:18:45 78:04	30:00			
	1:18:56 78:15	00:11	Instructor directs tanker operator to area of burning close to machinery	Ok, you've got to protect all the assets here	
			Trainee extinguishes flames with squirt bottle	I know we haven't done suppression but we try to put our water along the edge – there's no real point in putting water in there. Try to put it along the edge of the fire – that way we get the best bang for our buck	
		00:49	Instructor uses drip torch to accelerate burning of remaining fuel, then indicates area at top of the slope	We're going to have the biggest problem here. We haven't got a continuous break so see if you can lay a foam layer across here to control it, as quick as you can	
			Trainee applies foam to break in control line	I want it right out to the edge. What are the resources...we've got a helicopter and a tanker here...they look good at the moment	
			Instructor moves helicopter	I'll put him over here – we don't want him in the flames	

Segment 5: Bush fire- fighter safety and fire suppression techniques (continued)	80:37	2:33	Fire has consumed most of the fuel up to the control line. Instructor indicates foam layer	Once you don't get enough heat to evaporate the moisture out of this then it won't reach ignition temperature....and even this one here – there might be enough fire to burn the house...(but probably not)	
		2:59		Ok we're on suppression so all of the suppression crew put this out here and go around the edges – we don't worry about the middle	
			Addresses foam operator	We still need you up here	
			Crew proceeds as instructed	You can use more than one squirt and try different spray patterns to see how effective they are. We need to black out this table – blackout means no red showing	
			Addresses foam operator	We can put out this end	
			Crew finishes mopping up	So in reality we want to black out to the (inaudible) Ok any questions? It's not high brain stuff picturing what's going to happen in the landscape, what the fire behaviour is going to be like. Know where the topography is, put yourself somewhere safe and it works. It's not complicated, being in the right spot where the radiant heat is not going to get you. Is everyone around that? Ok let's go back to the classroom.	
	1:24:44	5:48	Completed		